Vanuatu Community-based Climate Resilience Project (VCCRP)

Annex 3: Economic and Financial Analysis

Accredited Entity: Save the Children Australia

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Contents

1.1 Introduction

1. As described in the funding proposal the aim of the Vanuatu community-based climate resilience project (VCCRP) is to support highly vulnerable rural communities across 29 Area Councils in Vanuatu to increase their resilience to climate variability and change by implementing targeted adaptation actions and facilitating decentralized governance structures that enable rural populations to adapt to changing climate trends and reduce disaster risk. The project's adaptation package provides a menu of actions to support households and communities to address key drivers of climate change vulnerability, minimize exposure and sensitivity and build resilience to unavoidable impacts. The adaptation package includes community-based, locally-led actions focused on minimizing sensitivity of food systems (agriculture and fisheries), reducing dependence on vulnerable income-generating resources through alternative livelihood options, improving access to critical services and addressing social inequities that exacerbate climate vulnerability.
2. The project's goal statement is that IF vulnerable rural communities in Vanuatu have improved access to climate information, adaptation planning and implementation capacity, THEN they will be less vulnerable to the unavoidable impacts of climate change, BECAUSE household food security and livelihoods will be less impacted by increasing temperatures, changing rainfall patterns and increasing extreme weather events.
3. The project will directly reach 90,157 people in 19,556 households and 282 communities across all six provinces (33% of the total population or 43% of the rural population) and a further 110,000 people indirectly (a further 40% of total population or 52% of the rural population). By working directly with communities and indirectly via building governance capacity, the project will reach almost all rural communities. Further, the adaptation package approach gives communities options to select the most appropriate and effective adaptation actions and provides ownership of the solutions that minimize vulnerability and build on local knowledge, skills and innovation.
4. The country's population of approximately 272,000 (2016 mini census) is spread over 68 islands and 75% of people live in rural and often remote communities. With 94% of the population living within 5 km of the coast and 60% living within 1 km of the coast, coastal environments and natural resources play a vital role in the subsistence and commercial life of ni-Vanuatu. This long traditional connection and dependence on natural resources stems from the fact that 65 of the 83 islands that make up the Vanuatu archipelago have been inhabited for thousands of years. This has enabled the country's people to acquire a profound understanding of their land, sea and climate. Generational knowledge, combined with the expertise that results from being primary managers and beneficiaries of natural resources, is a keystone to local livelihoods, cultural identity, and the ability of dispersed rural populations to cope with disaster. However, an increasingly unpredictable climate is challenging the limits of local and traditional experience, while threatening significant national and community level impacts into the future.
5. In terms of climate projections, the project's Feasibility Study states the following:
6. There is very high confidence in the direction of long-term change in several key climate variables, specifically increases in mean and extreme air and sea temperatures, sea level rise and ocean acidification.
7. Climate change projections for Vanuatu have been delivered by the Pacific Climate Change Science Program (PCCSP), led by the Australian Government in collaboration with the Vanuatu Meteorological and Geohazards Department (VMGD) of the Government of Vanuatu (CSIRO & BoM 2014; 2015). As well as the Risk Governance Assessment Report (UNDP 2013), and collectively can be summarised as follows:

- Increases in daily ***air temperatures*** are projected across all of Vanuatu for minimum, mean and maximum daily temperatures. Compared to 1995, temperature will be higher by 1.2°C (global 1.9°C) by 2040, and 2.3°C (global 3.6°C) by 2070 (high confidence).
- ***Extreme air temperatures*** (e.g. heatwaves) will reach higher levels and become more frequent. By 2040, the current 1-day maximum occurring once every 20 years will occur every 2 years (high confidence).
- Increases in ***sea surface temperature***s will mean reefs around Vanuatu will experience conditions that exceed thermal thresholds known to cause coral bleaching (above 29.5°C) more often, but impacts will be spatially and temporally variable (high confidence).
- ***Extreme sea surface temperatures*** (marine heatwaves) will occur more often, increasing from 10% of the time currently to 25% of the time by 2040 (high confidence).
- Projections of ***rainfall changes*** are low confidence, and trends are unclear given the very high climate variability in Vanuatu. There are a range of possible future trajectories, from wetter to drier, largely determined by future changes in the South Pacific Convergence Zone (SPCZ). This will pose challenges to planning and policy development, and therefore planning should consider both a wetter and a drier future.
- ***Extreme rainfall*** will become more frequent and intense (high confidence). By 2040, the 1 in 100-year event intensity will increase to 10-11%. This change is the same across all islands. Frequencies of current extreme events will increase by 1.2-2.5%.
- The duration of ***dry periods (droughts)*** will become longer (low confidence). The 1 in 5-year event will lengthen from 19 days to 28 days.
- ***Tropical cyclones*** are projected to be less frequent (decrease in cyclone formation) but more intense (medium confidence).
- ***Sea level*** is estimated to be currently increasing by 6mm/year since 1960 or 4mm/year since 1993. Models simulate an increase of up to 18 cm by 2030, with increases of up to 89 cm indicated by 2090 (high confidence). Information on local vertical land movement is crucial. For example, in Port Vila, a sea level rise of 159 cm is projected for 2100, when the observed sinking of 4.8 mm/year is taken into account.
- In 20 years', it is projected that continued ***ocean acidification*** will result in seawater chemistry that is only marginal for calcification, affecting reef accretion and structure on 80% of coral reefs around the world, including those in Vanuatu (Lenton et al. 2015).

8. The projected changes in the annual and seasonal mean climate for Vanuatu under the medium (RCP6.0) and high (RCP8.5) emissions scenarios are provided in Table 4. Projected changes are given for 2030 and 2090 as representative short- and long-term future planning horizons, relative to a 20-year period centred on 1995. Values represent the multi-model mean change, with the 5–95% range of uncertainty in brackets.

9. The adaptation options for small islands that are most cost effective and successful have been shown to be community-based resource management approaches, including nature-based solutions to coastal protection. Further, global reviews of marine resources in particular (e.g. Gaines et al., 2018) have found that to optimise resilience to climate change, the primary need is to ensure that basic management is effective and sustainable. Therefore, supporting communities to maintain healthy ecosystems and restore degraded habitats, fortifies food and livelihood security and reduces vulnerability to disaster risk, which are paramount for increasing resilience to future climate uncertainty and change. **This project therefore focuses on adaptations that support community-based actions and increase local capacity to build sustainable food-systems, livelihoods and reduce disaster risk.**

Current available evidence indicates the climate change challenges facing communities in Vanuatu are due to increasing frequency and/or intensity of extreme events:

1. **Temperatures: air and sea** (including minimum, mean and maximum daily temperatures and events such as heatwaves). Slow onset change is also a key longer-term driver.
2. **Rainfall patterns** (including increased duration of dry periods, changing frequency and intensity of extreme rainfall and ENSO associated rainfall).
3. **Tropical cyclones** (increased intensity, not frequency, predicted including severe wind and waves, and intense rainfall and flooding).

10. In addition to addressing these specified sectors and climate risks, the community adaptation actions implemented through this project will provide co-benefits that will increase resilience to climate impacts out of scope, such as water insecurity and health outcomes (see Table 5). These co-benefits will be achieved through the capacity and resilience building activities conducted with communities, as well as through partnerships and collaboration with complementary projects, such as the Vanuatu Department of Water projects.

11. Project activities are designed to respond to the needs and gaps identified through the vulnerability assessment, including: increasing local capacity to understand the implications climate change holds, generate locally-appropriate adaptation plans, and access and utilize up-to-date climate information and actionable early warnings; building a flexible, scalable package of adaptation actions to build environmental resilience (via nature-based solutions), increase food security and diversify livelihood structures; and support enhanced system capacity at all levels to support local adaptation sustainably. These three components are outlined below.

    - **Component 1: Government, civil society and communities are strengthened to support local resilience to climate change impacts, including by providing access to climate information and early warnings**
    - **Component 2: Scalable, locally appropriate actions are implemented to meet community adaptation needs to create climate-resilient, sustainable development pathways**
    - **Component 3: Institutional adaptive capacity is enhanced by building adaptive governance systems at the local level and enhancing local-provincial-national linkages**

12. Component 1 aims at resilience of rural communities: their awareness of climate change impacts; preparedness to proactively act when extreme weather events (e.g cyclones or drought) occur, based on reliable early warning systems; and to make long term development decisions based on participatory local adaptation plans that incorporate up-to-date climate information. Component 1 builds community and institutional capacity at the local level, integrated into a provincial structure, to plan for and respond to the current and anticipated impacts of climate change.

13. Component 2 focuses on strengthening agriculture and fisheries systems to achieve food security and promoting economic activities through local value-chain improvements in order to diversify livelihoods options. This component is the core of the project and is built around the adaptation package menu which is flexible and scalable to community contexts. This component is relevant to the economic analysis as all the investments into adaptation measures are envisaged under it.

14. Component 3 - This component is key to ensuring the sustainability of the adaptation packages approach, by embedding the system of community adaptation planning and

prioritization of actions into national and provincial planning and budgeting cycles. The component will also build the capacity of provincial and national actors to access and effectively use future flows of climate finance.

15. The national vulnerability assessment was conducted as part of the feasibility study which drew on available socio-ecological data for exposure to hazards, food and livelihood systems and knowledge on which community-level factors increase sensitivity and/or undermine adaptive capacity. Stakeholder consultation and field missions validated the results. The assessment used indicators for hazard, exposure, sensitivity and adaptive capacity (method details available in Annex 2) consistent with the National Vulnerability Assessment Framework. The results provide a relative ranking of all Area Councils in Vanuatu from highest to lowest vulnerability to climate change, noting that all communities in Vanuatu are vulnerable to climate change. The results were used to identify suitable adaptation options and strategically target beneficiaries (i.e. those that are most vulnerable and marginalized). The results identified the main drivers (or sources) of vulnerability, which were used to identify a suite of adaptation actions that specifically address the main sources of vulnerability and provide a 'menu' or package of adaptations for implementation.

16. The envisaged GCF budget for the implementation of prioritised climate adaptation measures is USD 5,046,329 while USD 22,729,692 is expected to fund technical assistance (TA) activities, non-investment related equipment, and travel costs. The total project budget is USD 27,776,021, all of which is to be provided by the GCF in the form of a grant. The co-financing amount is USD 6,166,270, provided by the Vanuatu Government and the Australian aid program.

1. Project benefits

17. The proposed project aims to build the adaptive capacity of vulnerable Local Authorities and to implement a variety of adaptation interventions for the increased climate resilience of communities and livelihoods. The aim is to initiate an overarching approach that would support the identification of locally-led, most suitable interventions and in doing so lay the foundations for further scaling-up beyond the programme lifetime.

18. The focus of the adaptation investments under this component is divided into four main categories:

- **EWS (Early Warning System) communication equipment** – the project will build on GCF FP035 (Van-KIRAP) to disseminate useable, accessible climate information to the community level, helping ensure that the climate information generated under Van-KIRAP reaches the most vulnerable communities. Currently, there is a significant gap in terms of communication equipment implemented. The measure will support development and distribution of CIS IEC products to inform community-level climate change adaptation planning processes.

- **Natural based solutions for coastal management** - establish living barriers (i.e. vetiver and/or native trees) to storm winds, erosion or landslide zones to fortify slopes and reduce erosion, support reforestation of damaged forests and water catchments using native species (including native coastal vegetation) and micro check dams for erosion control and groundwater recharge, establish or enhance traditional tabu areas for conservation of forest resources, including biodiversity, distribute preventive species for erosion control, including establishing Area Council agro-forestry nurseries, and tools to support implementation

- **Climate resilient agriculture in the context of Vanuatu** - Establish field demonstrations sites for soil erosion minimisation methods and facilitate groundwater recharge, establish field demonstrations of climate-resilient agriculture techniques (including traditional methods where appropriate), establish new or support existing (e.g. Vanuatu Agriculture Research Training Centre (VARTC)) nurseries at Area Council for raising climate-resilient seed stocks, including native food and cash crops varieties, and germinating seedlings for food and cash crops, distribute resilient native food and cash crops planting materials to communities, including (as applicable) identified climate-resilient varieties of: fruit and nut trees, coconut, vegetables, cacao, coffee and kava, distribute simple agricultural tools to communities to increase production of resilient food and cash crops (e.g. earth huger, rotavator).

- **Climate-resilient food processing and preservation established to support food security and diversification of livelihoods options -** Purchase and install selected food preservation and storage systems in target communities (copra dryers and solar freezers).

19. Based on above, the project has the potential to generate a broad range of environmental, social, and economic benefits and co-benefits, some of which include:

- Avoided losses and damage to equipment, livelihoods, and infrastructure due to implementation of EWS related communication equipment.
- Increased capacity of relevant stakeholders to identify, develop, and implement tailored and focused adaptation measures and needs;
- Avoided loss of vulnerable habitats such as coral reefs due to switch in fishery practices;
- Avoided soil and coast erosion, and mechanical damages caused by cyclones;
- Avoided biodiversity losses due to mangrove restoration;
- Avoided GHG emissions – renewable energy based technologies, agroforestry;
- Increased food security due to increased processing and storage capacity;
- Avoided losses due to reliance on imported food;
- Avoided cost resulting from erosion and soil damage due to implementation of soil and water conservation techniques;
- Avoided crop yield losses due to implementation of soil and water conservation techniques and introduction of climate resilient varieties;
- Reduced flooding and seawater intrusion due to coastal management interventions;
- Reduced erosion and loss of coast, and loss of infrastructure such as roads;
- Avoided loss of biodiversity due to, for example, mangrove planting.

2. Economic analysis

20. An economic analysis of the project has been performed to assess the incremental adaptation benefits to climate change for communities. The economic cost-benefit analysis uses a cash flow model over a 10-year period for storage and processing equipment, 20-year period for fishery and agriculture related interventions, and a 40-year period for coastal management natural based solutions. These periods include all investment and operational costs of the project, as well as the monetised revenues from resulting externalities such as avoided losses.

2.1. Approach

21. As already described in the funding proposal and Annex 2 – Feasibility Study, there is a significant lack of capacity related to climate adaptation on all levels and among all stakeholders in Vanuatu. Two of the three components (Components 1 and 3) of this project, therefore, aim to build community and institutional capacity at the local level to plan for and respond to the current and anticipated impacts of climate change, as well build the capacity of provincial and national actors to access and effectively use future flows of climate finance, implement future adaptation actions and support adaptative governance processes at the local level. **These investments are necessary to help catalyse a paradigm shift in resilience in Vanuatu**. One of the project components (Component 2), is built around the adaptation package menu, which is flexible and scalable to community contexts within the above-mentioned focal areas covered by the scope of the project. The specific adaptation actions assessable under this analysis are under Component 2.
22. The economic analysis covers the interventions for which the scale is known to some extent. Due to nature of variety and number of possible adaptation interventions, it was not possible and feasible to test every single possible intervention, especially due to lack of data. Furthermore, the identification of the scale of interventions is significantly hindered due to the great diversity of relevant parameters. Indeed, Vanuatu is extremely diverse in terms of population distribution, geographical morphology, distribution of climate impacts and corresponding adaptation needs.
23. Therefore, the approach undertaken for economic analysis of this project was based on identifying the most **probable and defined** interventions that would reflect the most pressing adaptation needs. As already stated, the proposed project is aiming at four main thematic areas – **Distribution of EWS related satellite communication equipment**, **Natural based solutions for coastal management, Climate resilient agriculture in the context of Vanuatu, Climate-resilient fisheries for food security and livelihood development, and Climate-resilient food processing and preservation established to support food security and diversification of livelihoods options.** For the purpose of the economic analysis, the four most representative measures were identified - one for each thematic area. The measures were selected based on the Vanuatu climate rationale, project design, the outcomes of stakeholder consultations, the literature review, and discussions with the AE – Save the Children Australia. The following measures were tested by the economic analysis:

- **Measure 1: EWS communications equipment**
- **Measure 2: Nature based solutions - coastal management**
- **Measure 3: Climate resilient agriculture -taro and yam as examples**
- **Measure 4: Food processing and storage**

2.2. Measure 1: EWS communication equipment

24. The measure proposed in the project aims at enhancing community EWS infrastructure where gaps exist, through installation of small rooftop satellite dishes, and establish system for CDCCCs to on-sell data capacity to cover costs (activity 1.3.1.2). It is assumed that one community access satellite internet connection will be installed in each CDCCC, in the 29 Area Councils covered by the project. Therefore, a total of 261 rooftop satellite dishes will be installed.

25. Annually, Vanuatu is affected by an average of 2.6 cyclones (ranging from 0-6 per year in recent decades). According to the Disaster Risk Profile of Vanuatu, presented in the Post-Disaster Needs Assessment- Tropical Cyclone Pam1, Vanuatu Adequate investment in EWS can contribute to significantly reduce the impacts on social and economic well-being. In a research conducted for Samoa in 2019[2], it was estimated that EWS could reduce the country´s damages and losses due to cyclones in 19,5%. This estimation considered damage to houses (loss of household possessions), agriculture (crops damaged, implements and equipment damaged or lost), fishery (fisheries Division infrastructure; nets and other fishing equipment damaged), livestock (most poultry, farm animals, forages, and straw damaged or lost). For estimating the benefit of this measure, a conservative approach was taken, considering the lower estimation (19,5%). Sensitivity analysis was conducted regarding this value.

26. The main benefits are related to agriculture (crops damaged, implements and equipment damaged or lost), fishery (fisheries Division infrastructure; nets and other fishing equipment damaged), livestock (most poultry, farm animals, forages, and straw damaged or lost).

Counterfactual analysis

27. The counterfactual analysis for this measure is based on the estimated negative impacts of climate-related events. In the absence of the project, investment would most likely not occur and so benefits per unit of investment are based on the comparison of the "climate change impact" situation and the "with project" situation.

Assumptions

28. The economic cost-benefit analysis, over a 40-year period was conducted for the implementation of coastal management investments.

Table 1 Assumptions for measure 1.

Cost calculations on a per investment basis			
Parameter	**Sources and assumptions elaboration**	**Unit**	**Value**
Input data			
Discount rate	https://documents1.worldbank.org/curated/en/137341508303097110/pdf/120479-WP-P156647-PUBLIC-SydneyRPFFA.pdf	%	5%

[1] Post-Disaster Needs Assessment- Tropical Cyclone Pam, March 2015. https://www.gfdrr.org/sites/default/files/publication/pda-2015-vanuatu.pdf

[2] Bapon S.H.M. Fakhruddin, Lauren Schick (2019). Benefits of economic assessment of cyclone early warning systems – A case study on Cyclone Evan in Samoa

Lifetime of investment	Assumption	Years	10%
Cyclone Pam damage to - agriculture	https://www.gfdrr.org/sites/default/files/publication/pda-2015-vanuatu.pdf	USD	$10,300,000
Cyclone Pam damage to – fishery	https://www.gfdrr.org/sites/default/files/publication/pda-2015-vanuatu.pdf	USD	$2,390,000
Cyclone Pam damage to - manufacturing	https://www.gfdrr.org/sites/default/files/publication/pda-2015-vanuatu.pdf	USD	$10,680,000
Cyclone Pam damage to – tourism	https://www.gfdrr.org/sites/default/files/publication/pda-2015-vanuatu.pdf	USD	$52,770,000
Damage reduction potential of EWS information	Bapon S.H.M. Fakhruddin, Lauren Schick (2019). Benefits of economic assessment of cyclone early warning systems – A case study on Cyclone Evan in Samoa	%	19.5%
Frequency of occurrence of typhoons of the PAM scale	Assumption based on https://documents1.worldbank.org/curated/en/137341508303097110/pdf/120479-WP-P156647-PUBLIC-SydneyRPFFA.pdf	#	0.2
Probability of correct forecast	Bapon S.H.M. Fakhruddin, Lauren Schick (2019). Benefits of economic assessment of cyclone early warning systems – A case study on Cyclone Evan in Samoa	#	0.9
Total amount of community access satellite internet connections	Project proposal document	#	261
Investment costs one access satellite internet connections (one satellite dish - procurement and instalment)	Annex budget file	USD	$6,242
Total investment costs for satellite communication equipment	**Calculated**	**USD**	**$1,629,162**
Operational costs per satellite dish	Annex budget file	USD/a	$89
Total operating costs	**Calculated**	**USD/a**	**$23,229**

Benefits calculations			
Population coverage	Project proposal document	%	33%
Estimated annual avoided damage due to installation of community access satellites	**Calculated**	**USD/a**	**$881,930**

Results

29. The benefits were calculated based on implementing 216 rooftop satellite dishes - EWS communication equipment as well as CDCCC resource kits. The following table presents the results of Key Performance Indicators (KPIs):

Table 2 KPIs for measure 1.

Net costs / benefits	USD	Calculated	**$ 4,811,093**
EIRR	%	Calculated	**111%**
ENPV	**USD**	Calculated	**$ 3,305,737**
Net costs / benefits per year	**USD / year**	Calculated	**$ 481,109**

30. The results show that all KPIs are positive in terms of the economic feasibility of the proposed project. The ENPV is substantial USD 3,305,737 and the EIRR is at 111%, much higher than the used discount rate of 5% making this measure, under presented assumptions, economically viable.
31. Various scenarios were tested to establish the economic viability of measure 1 based on either changes in the costs of investment or changes in the level of benefits. The results are presented in the following table.

Table 3 Sensitivity analysis for measure 1.

Project costs	ENPV of the investment	EIRR of the investment
70%	$3,756,364	315%
80%	$3,606,155	196%
100%	$3,305,737	111%
120%	$3,005,318	76%
140%	$2,704,900	56%
Benefits	**ENPV of the investment**	**EIRR of the investment**
70%	$1,863,388	54%
80%	$2,344,171	70%
100%	$3,305,737	111%
120%	$4,267,302	174%
140%	$5,228,868	290%

32. The results show a positive ENPV and EIRR in all scenarios with alternating level of costs and income, respectively. Based on the assumptions described above, measure 1. can be justified on economic grounds.

2.3. Measure 2: Nature based solutions - coastal management

33. The measure 2. would include the interventions in rehabilitation of mangrove areas that would include water habitats and mangrove forests. Furthermore, there are two other types of interventions to be included: vetiver grass and agroforestry interventions. Vanuatu is one of the most climate vulnerable countries in the world. There is a severe impact resulting from quite often and devastating cyclones. As a result, there is a significant level of coastal and soil erosion caused by strong and powerful winds and precipitation. Present natural based solutions are proven and highly effective interventions in increasing climate resilience within the context.
34. The main benefit is related to avoided losses due decreased soil and coast erosion. Additionally there is a number of other benefits resulting from these interventions such as carbon sequestration resulted in increasing the forestry cover. Mangrove rehabilitation would also result in decreased losses in marine habitats and would contribute to biodiversity preservation in areas that are within the reach of mangrove protection area.

Counterfactual analysis

35. The counterfactual analysis for this measure is based on the estimated negative impacts of climate-related events. In the absence of the project, investment would most likely not occur and so benefits per unit of investment are based on the comparison of the "climate change impact" situation and the "with project" situation.

Assumptions

36. The economic cost-benefit analysis, over a 40-year period was conducted for the implementation of coastal management investments.

Table 4 Assumptions for measure 2.

Cost calculations on a project level			
Parameter	**Sources and assumptions elaboration**	**Unit**	**Value**
Input data			
Afforestation interventions			
Investment costs per ha + Cost of agricultural tool kits envisaged under Activity 2.1.1.4.	Assumption based on https://www.rdani.org.au/files/pages/projects/nirdb/farm-forestry-northern-inland-forestry-investment-group/manual-for-planted-farm-forestry-appendices/Appendix_C.pdf	USD/ha	$1,294
Annual OPEX costs per ha	https://spccfpstore1.blob.core.windows.net/digitallibrary-docs/files/60/60aed30e6edd1f0b26278515ca7d8f2f.pdf?sv=2015-12-11&sr=b&sig=y1zWVlAnO8khQoXGtVrcD%2Fqgl85JZY6vqQgfniWXE54%3D&se=2022-01-08T13%3A15%3A21Z&sp=r&rscc=public%2C%20max-age%3D864000%2C%20max-stale%3D86400&rsct=application%2Fpdf&rscd=inline%3B%20filename%3D%22Fiji_RESCCUE_Afforestation_benefits_and_costs.pdf%22	USD/ha	$300
Total project area to be covered by afforestation	Project proposal document, budget annex	ha	500
Lifetime of investment	Assumption	Years	40
Total investment cost for afforestation	**Calculated**	**USD**	**$646,933**
Annual OPEX costs total	**Calculated**	**USD/a**	**$150,000**
Discount rate	https://documents1.worldbank.org/curated/en/137341508303097110/pdf/120479-WP-P156647-PUBLIC-SydneyRPFFA.pdf	%	5%
Vetiver Grass			
Investment costs per m	Assumption based on https://www.vetiver.org/TVN_Vetiver_Coastal_Engineering.pdf	USD/m	$6
Total meters of vetiver grass living fences	Project proposal document	m	100,000

Lifetime of investment	Assumption	Years	40
Total investment costs for vetiver grass living fences	**Calculated**	**USD**	**$646,983**
Mangrove replanting			
Investment costs per ha - mangrove restoration, replanting	https://www.researchgate.net/publication/263199529_Cost-benefit_analysis_of_mangrove_restoration_in_Thi_Nai_Lagoon_Quy_Nhon_City_Vietnam	USD/ha	$5,000
Number of ha under mangrove restoration - project level	Project proposal document, budget annex	ha	143
Lifetime of investment	Assumption	Years	40
Total investment into mangrove replanting - project level	**Calculated**	**USD**	**$715,000**

Benefits calculations on a per investment basis			
Afforestation interventions			
Social cost of avoided erosion per ha	Assumption based on https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/?cid=nrcs142p2_054028. Assumption made under 100% erosion efficiency when compared with the social cost of erosion.	USD/ha/a	$250
GHG sequestration potential - per ha	Assumption based on https://www.researchgate.net/publication/321438111_Greenhouse_gas_emissions_and_carbon_sequestration_by_agroforestry_systems_in_southeastern_Brazil	t/ha	2
Social cost of carbon	https://www.oecd.org/env/cc/37321411.pdf	$/tCO2e	35
Total benefits of avoided erosion under agroforestry production	Calculated	**USD/y**	**$125,000**
Total GHG sequestration benefits	Calculated	**USD/y**	**$35,000**
Vetiver grass benefits			
Social cost of avoided erosion per ha	Based on https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/?cid=nrcs142p2_054028	USD/ha/a	$250
Hectares of land protected by vetiver grass	Project proposal document	ha	500
Efficiency potential for avoided erosion - vetiver grass	Assumption based on https://www.tucson.ars.ag.gov/isco/isco13/PAPERS%20R-Z/TRUONG.pdf	%	40%
GHG sequestration potential - per ha	Assumption based on https://vetiver.org/KEN_Vetiver%20and%20soil%20carbon%20by%20EP.pdf	t/ha/a	5.00

Total GHG sequestration benefits	**Calculated**	USD/y	**$17,500**
Annual benefit potential of avoided erosion	**Calculated**	**USD/a**	**$50,000**
Annual benefit potential of vetiver grass	**Calculated**	**USD/a**	**$67,500**
Mangrove benefits			
Marine habitats under protection of mangroves replanting	Project proposal document	ha	500
Benefit to avoided losses in fishery due to mangrove replanting	https://www.researchgate.net/publication/263199529_Cost-benefit_analysis_of_mangrove_restoration_in_Thi_Nai_Lagoon_Quy_Nhon_City_Vietnam	USD/ha/a	$350
Biodiversity related co-benefits of mangrove protection area	https://www.climatelinks.org/sites/default/files/asset/document/2017_USAID%20CEADIR_Cost-Benefit%20Analysis%20of%20Mangrove%20Restoration%20for%20Coastal%20Protection%20.pdf	USD/ha/a	$5
Hectares of mangrove forest (100ha protecting marine habitats, 100 ha protecting upland areas)	Project proposal document	ha	143
Ha of mangrove forest protecting upland areas	Project proposal document	ha	100
Efficiency potential for avoided erosion - mangrove forest	Assumption	%	50%
Total GHG sequestration benefits	https://raidboxes.io/wp-content/uploads/2019/05/Carbon-Sequestration-in-Mangroves.pdf	t/ha/a	8.1
Total GHG sequestration benefits	**Calculated**	**USD/a**	**$40,541**
Total benefit due to avoided losses in fishery	**Calculated**	**USD/a**	**$175,000**
Total biodiversity related co-benefits of mangrove protection area	**Calculated**	**USD/a**	**$769**
Total avoided erosion due to mangrove planting	**Calculated**	**USD/a**	**$12,500**

Results

37. The benefits were calculated on the basis of implementing agroforestry intervention on 500 ha area, vetiver grass lines in total of 100,000 meters, and 143 ha of mangrove forests restoration. The following table presents the results of Key Performance Indicators (KPIs):

Table 5 KPIs for measure 2.

Net costs / benefits	**USD**	**Calculated**	**$ 8,947,244**
EIRR	**%**	**Calculated**	**12%**
ENPV	**USD**	**Calculated**	**$ 2,355,878**

Net costs / benefits per year	**USD / year**	**Calculated**	**$ 447,362**

38. The results show that all KPIs are positive in terms of the economic feasibility of the proposed project. The ENPV is substantial USD 2,355,878 and the EIRR is at 12%, higher than the used discount rate of 5% making this measure, under presented assumptions, economically viable.

Sensitivity analysis

39. Various scenarios were tested to establish the economic viability of measure 1 based on either changes in the costs of investment or changes in the level of benefits. The results are presented in the following table.

Table 6 Sensitivity analysis for measure 2.

Project costs	ENPV of the investment	EIRR of the investment
60%	$3,958,340	23%
80%	$3,157,109	17%
100%	$2,355,878	12%
120%	$1,554,647	9%
140%	$753,417	7%
Benefits	**ENPV of the investment**	**EIRR of the investment**
60%	$(188,935)	4%
80%	$1,083,472	9%
100%	$2,355,878	12%
120%	$3,628,285	16%
140%	$4,900,692	19%

40. The results show a positive ENPV and EIRR in all scenarios with alternating level of costs and income, respectively. Based on the assumptions described above, measure 2. can be justified on economic grounds.

2.4. Measure 3: Climate resilient agriculture - taro and yam as examples

41. Measure 3. would include the implementation of soil and water conservation techniques in order to avoid erosion. Additionally, this measure would involve the introduction of climate resilient varieties of indigenous cash crops. Subsistence farming in Vanuatu is dominated by production of taro and yam. Yam is the common name for plant species in the genus Dioscorea that form edible tubers. Yams are perennial herbaceous vines cultivated for the consumption of their starchy tubers. Yam is traditionally grown in the Pacific region and has varieties that are drought and salt tolerant. Even though it is expected that intervention will cover other crops and agricultural production, for the purpose of economic analysis taro and yam were tested as the most dominating cash crops in Vanuatu.

42. The calculations were undertaken under the assumption that the project will finance investments into climate resilient interventions on total of 840 ha, under additional assumption that half of it would be include taro and other half yam production. The resulting benefits relate to avoided crop losses due to decreased soil erosion and improved water conversation, and reduced spoilage level caused by pests and diseases.

Counterfactual analysis

43. The economic analysis of the measure included a comparison of baseline and alternative scenarios. This counterfactual analysis compared the production of taro and yam with and without introduced climate resilient interventions.

Assumptions

44. The economic cost-benefit analysis, over a 20-year period was conducted for the production of 456 ha of saltwater and drought tolerant yam put against the baseline scenario of the 456 ha taro production.

Without the project - Baseline scenario:

Table 7 Assumptions for measure 3. – Baseline scenario

Input data			
Budget for climate resilient agriculture interventions (Activities 2.1.2, 2.2.1, 2.2.2.)	Budget annex	USD	$1,679,326
Average price per ha for taro and yam production	Assumption	USD/ha	$2,000
Total number of ha under M2 interventions	Calculated	Ha	840
Discount rate	https://documents1.worldbank.org/curated/en/137341508303097110/pdf/120479-WP-P156647-PUBLIC-SydneyRPFFA.pdf	%	5%

WITHOUT THE PROJECT SCENARIO

Taro production - baseline/no project			
Average yield per ha	https://www.fao.org/3/ac450e/ac450e.pdf	tonnes per ha	6.2
Value per tonne of yield	https://core.ac.uk/download/pdf/223128647.pdf	USD/tonne	$150
Marginal investment costs	https://cdn.sare.org/wp-content/uploads/20171204131722/945223publication-on-cost-of-production-for-crop-diversification.pdf	USD/ha/a	$1,700
Marginal operating costs	Assumption	USD/ha/a	$250
Annual productivity damage caused by erosion	https://www.sciencedirect.com/science/article/pii/S2095633921000423	%	25%
Direct mechanical losses due to cyclones - annual	Post-Disaster Needs Assessment (PDNA) Cyclone Pam 2015	%	4%
Increase in mechanical losses due to cyclones after 10 years after project implementation - annual	Assumption based on climate rationale and PDNA	%	8%
Diseases and pests in subsistence crops - spoilage factor - annual	Annex 2 - feasibility report	%	30%

Number of ha under taro production - project level estimation	Calculated under assumption of split between taro and yam of 50:50)	%	50%
Number of ha under taro production - project level estimation	Calculated	Ha	420
Lifetime of investment	Assumption	Years	20
Yam production - baseline/no project			
Average yield per ha	https://www.fao.org/3/ac450e/ac450e.pdf	tonnes per ha	8
Value per tonne of yield	https://core.ac.uk/download/pdf/223128647.pdf	USD/tonne	$150
Marginal investment costs	https://cdn.sare.org/wp-content/uploads/20171204131722/945223publication-on-cost-of-production-for-crop-diversification.pdf	USD/ha/a	$1,700
Marginal operating costs	Assumption	USD/ha/a	$250
Annual productivity damage caused by erosion	https://www.sciencedirect.com/science/article/pii/S2095633921000423	%	25%
Direct mechanical losses due to cyclones - annual	Post-Disaster Needs Assessment (PDNA) Cyclone Pam 2015	%	4%
Increase in mechanical losses due to cyclones after 10 years after project implementation - annual	Assumption based on climate rationale and PDNA	%	8%
Diseases and pests in subsistence crops - spoilage factor - annual	Annex 2 - feasibility report	%	30%
Number of ha under yam production - project level estimation	Calculated under assumption of split between taro and yam of 50:50)	%	50%
Number of ha under yam production - project level estimation	Calculated	Ha	420
Lifetime of investment	Assumption	Years	20

Results

45. Baseline scenario:

The benefits were calculated on the basis of implementing 420 ha of taro and yam. The following table presents the results of Key Performance Indicators (KPIs):

Table 8 KPIs for measure 3 - Baseline scenario – taro

Net costs / benefits	USD	**Calculated**	**$ (134,627)**
EIRR	%	**Calculated**	**-2%**
ENPV	**USD**	**Calculated**	**$ (333,926)**
Net costs / benefits per year	**USD / year**	**Calculated**	**$ (6,731)**

46. The KPIs show that the EIRR is negative and below the discount rate with ENPV being negative as well. This clearly shows that under the current climate impacts taro production is not being economically viable. The main reason behind it is a significant potential loss of around 60% as a result of a tidal cyclones, erosion, and pest and diseases. Therefore, the taro production is not economically viable under baseline assumptions listed above.

Table 9 KPIs for measure 2 - Baseline scenario – yam

Net costs / benefits	USD		**$ 582,288**
EIRR	%		**6%**

ENPV	**USD**		**$**	**72,436**
Net costs / benefits per year	**USD / year**		**$**	**29,114**

47. The KPIs show that the EIRR is slightly above discount rate and ENPV is just sightly positive. This shows that under the current climate impacts taro production is being economically viable. However, the KPIs are on the borderline of being viable.

Alternative scenario:

48. Alternative scenario envisages the introduction of soil and water conservation technologies and climate resilient varieties in already ongoing taro and yam production.

Assumptions

Table 10 Assumptions for measure 3. – Baseline scenario

Taro production - alternative scenario/with project			
Average yield per ha	https://www.fao.org/3/ac450e/ac450e.pdf	tonnes per ha	6.2
Value per tonne of yield	https://core.ac.uk/download/pdf/223128647.pdf	USD/tonne	$150
Marginal investment costs	Assumption + cost for soil conservation interventions	USD/ha/a	$2,000
Marginal operating costs	Assumption	USD/ha/a	$250
Annual productivity damage caused by erosion	Assumption - 20% reduction in erosion due to the soil conservation	%	5%
Direct mechanical losses due to cyclones - annual	Reduction of 3% due to introduction of climate resilient practices	%	1%
Increase in mechanical losses due to cyclones after 10 years after project implementation - annual	Reduction of 4% due to introduction of climate resilient practices	%	4%
Diseases and pests in subsistence crops - spoilage factor - annual	Assumption - 25% reduction in erosion - climate resilient practices	%	5%
Number of ha under taro production - project level estimation	Calculated under assumption of split between taro and yam of 50:50)	%	50%
Number of ha under taro production - project level estimation	Calculated	Ha	420
Lifetime of investment	Assumption	Years	20
Yam production -alternative scenario/with project			
Average yield per ha	https://www.fao.org/3/ac450e/ac450e.pdf	tonnes per ha	8
Value per tonne of yield	https://core.ac.uk/download/pdf/223128647.pdf	USD/tonne	$150
Marginal investment costs	Assumption + cost for soil conservation interventions	USD/ha/a	$2,000

Marginal operating costs	Assumption	USD/ha/a	$250
Annual productivity damage caused by erosion	Assumption - 20% reduction in erosion due to the soil conservation	%	5%
Direct mechanical losses due to cyclones - annual	Reduction of 3% due to introduction of climate resilient practices	%	1%
Increase in mechanical losses due to cyclones after 10 years after project implementation - annual	Reduction of 4% due to introduction of climate resilient practices	%	4%
Diseases and pests in subsistence crops - spoilage factor - annual	Assumption - 25% reduction in erosion - climate resilient practices	%	5%
Number of ha under yam production - project level estimation	Calculated under assumption of split between taro and yam of 50:50)	%	50%
Number of ha under yam production - project level estimation	Calculated	Ha	420
Lifetime of investment	Assumption	Years	20

Results

49. The alternative scenario benefits were calculated on the basis of implementing 420 ha of taro and yam production. The following table present the results of Key Performance Indicators (KPIs):

Table 11 KPIs for measure 3 - Alternative scenario – taro

Net costs / benefits	USD	**Calculated**	**$ 2,807,927**
EIRR	%	**Calculated**	**19%**
ENPV	**USD**	**Calculated**	**$ 1,275,977**
Net costs / benefits per year	**USD / year**	**Calculated**	**$ 140,396**

50. The results show that all KPIs are positive in terms of the economic feasibility of the proposed project. The ENPV is USD 1,275,977 and the EIRR is at 19% higher than the used discount rate of 5% making this measure, under presented assumptions, economically viable. The counterfactual analysis clearly shows that the introduction of climate resilient interventions into taro production is economically viable while the baseline scenario is not.

Table 12 KPIs for measure 3 - Alternative scenario – yam

Net costs / benefits	USD	**Calculated**	**$ 4,415,712**
EIRR	%	**Calculated**	**27%**
ENPV	**USD**	**Calculated**	**$ 2,181,375**
Net costs / benefits per year	**USD / year**	**Calculated**	**$ 220,786**

51. The results show that all KPIs are positive in terms of the economic feasibility of the proposed project. The ENPV is USD 2,181,375 and the EIRR is at 27% higher than the used discount rate of 5% making this measure, under presented assumptions, economically viable. The counterfactual analysis clearly shows that the introduction of climate resilient interventions into yam production is economically viable while and significantly improved compared to relevant baseline scenario.

Sensitivity analysis

52. Various scenarios were tested to establish the economic viability of measure 2 based on either changes in the costs of investment or changes in the level of benefits. The results are presented in the following table.

Table 13 Sensitivity analysis for measure 3 – alternative scenario – taro

Project costs	ENPV of the investment	EIRR of the investment
60%	$2,013,023	36%
80%	$1,644,500	26%
100%	$1,275,977	19%
120%	$907,454	14%
140%	$538,931	10%
Benefits	**ENPV of the investment**	**EIRR of the investment**
60%	$28,540	5%
80%	$652,259	13%
100%	$1,275,977	19%
120%	$1,899,696	25%
140%	$2,523,414	30%

Table 14 Sensitivity analysis for measure 3 – alternative scenario – yam

Project costs	ENPV of the investment	EIRR of the investment
60%	$2,918,421	46%
80%	$2,549,898	35%
100%	$2,181,375	27%
120%	$1,812,852	21%
140%	$1,444,329	17%
Benefits	**ENPV of the investment**	**EIRR of the investment**
60%	$571,779	12%
80%	$1,376,577	20%
100%	$2,181,375	27%
120%	$2,986,173	33%
140%	$3,790,971	39%

53. The results show a positive ENPV and EIRR in all scenarios with alternating level of costs and income, respectively. Based on the assumptions described above, measure 3. can be justified on economic grounds.

2.5. Measure 4: Food processing and storage

54. This measure involves the investment into solar dryers and freezers. Adaptation technologies for food preservation and storage (including solar dryers and solar freezers) will be supplied to communities to facilitate food processing. Target communities will be

provided with support towards long-term use, operation and maintenance of food processing and preservation systems. The focus is no copra dryers and solar freezers.

55. Benefits associated with this measure are mainly around the improved food security as those would allow access to food in case of extreme climate events. In that case, local communities would not entirely depend on imported food that is often expensive due to high transport costs. Additionally, the measure would result in consumption of renewable energy and result in GHG emissions reduction on a basis of supressed demand.

Counterfactual analysis

56. The counterfactual analysis for this measure is based on the estimated negative impacts of climate-related events. In the absence of the project, investment would most likely not occur and so benefits per unit of investment are based on the comparison of the "climate change impact" situation and the "with project" situation.

Assumptions

57. The economic cost-benefit analysis, over a 10-year period was conducted for the implementation of coastal management investments.

Table 15 Assumptions for measure 4.

Cost calculations			
Parameter	**Sources and assumptions elaboration**	**Unit**	**Value**
Solar copra dryer			
Discount rate	https://documents1.worldbank.org/curated/en/137341508303097110/pdf/120479-WP-P156647-PUBLIC-SydneyRPFFA.pdf	%	5%
Investment lifetime	Assumption	Years	10
Investment costs per one solar dryer	Annex budget file	USD	$5,204
Energy consumption of one copra solar dryer	https://energypedia.info/wiki/Solar_Drying	kWh/day	60
Copra batch size	https://www.sciencedirect.com/science/article/pii/S0301479720306629	kg	500
Copra reduction in mass - deducted moisture	https://www.sciencedirect.com/science/article/pii/S0301479720306629	%	50%
Solar dryer - annual operating days	https://www.sciencedirect.com/science/article/pii/S0301479720306629	days	250
Duration of drying - per batch	Assumption based on https://www.sciencedirect.com/science/article/pii/S0301479720306629	days	20
Number of batches per annum	Calculated	#/a	13
Amount of copra processed (dried) - per annum	Calculated	kg/a	3,125
Amount of coconut oil per one kg of copra	https://documents1.worldbank.org/curated/en/309941468180567229/pdf/FAU4.pdf	kg/kg	0.61

Annual coconut oil potential per one solar dryer	Calculated	kg	5,123
Annual solar energy consumption	Calculated	kWh/a	15,000
Solar refrigeration			
Investment costs per one solar freezer	Annex budget file	USD	$1,048
Marginal cost of energy consumed by solar refrigerator - per annum	Assumption based on https://www.osti.gov/servlets/purl/1481512	USD/kWh	$2
Annual solar energy consumption of solar freezer	Calculated	KWh/a	524
Refrigeration capacity per unit	Assumption	kg	50

Benefits calculations			
Solar copra dryer			
Value of coconut oil - food security increase	Assumption based on https://www.tridge.com/intelligences/coconut-oil/price	USD	$1
Total project budget allocated for copra dryers	Annex budget file	USD	$1,358,448
Total project costs allocation for installation of equipment	Annex budget file	USD	$307,525
Number of solar dryers to be implemented	Calculated	#	261
Total amount of coconut oil produced via dried copra - project level	Calculated	kg/a	1,337,291
Total amount of value of coconut oil produced via dried copra - project level	**Calculated**	**kg/a**	**1,337,291**
Vanuatu energy grid emission factor	https://procurement-notices.undp.org/view_file.cfm?doc_id=41770	kgCO2/kWh	1.3
Total energy consumed by solar copra dryers - per annum	Calculated	kWh/a	3,915,588
Total GHG emission reductions per year	Calculated	kgCO2/a	5,090,264
Social price of carbon	https://www.oecd.org/env/cc/37321411.pdf	$/tCO2e	35
Social cost of avoided GHG emissions	**Calculated**	**$/a**	**178,159**
Solar freezer			
Value of fish refrigerated - per kg	https://malffb.gov.vu/doc/fisheries/Aquaculture%20Development%20Plan.pdf	USD	$4

Total project budget allocated for copra driers	Annex budget file	USD	$273,627
Number of solar freezers to be implemented	Calculated	#	261
Total amount of fish stored in freezers - total amount at the given moment used as an assumption for annual volume	Calculated	kg/a	13,055
Total value of refrigerated fish - per annum	**Calculated**	**USD/a**	**52,219**
Vanuatu energy grid emission factor	https://procurement-notices.undp.org/view_file.cfm?doc_id=41770	kgCO2/kWh	1.3
Total energy consumed by solar copra dryers - per annum	Calculated	kWh/a	136,814
Total GHG emission reductions per year	Calculated	kgCO2/a	177,858
Social price of carbon	https://www.oecd.org/env/cc/37321411.pdf	$/tCO2e	35
Social cost of avoided GHG emissions	**Calculated**	**$/a**	**6,225**

Results

58. The benefits were calculated on the basis of implementing 261 solar copra dryers and 261 solar freezers. The following table presents the results of Key Performance Indicators (KPIs):

Table 16 KPIs for measure 4.

Net costs / benefits	USD	**Calculated**	**$**	**13,799,341**
EIRR	%	**Calculated**		**81%**
ENPV	**USD**	**Calculated**	**$**	**8,822,886**
Net costs / benefits per year	**USD / year**	**Calculated**	**$**	**1,379,934**

59. The results show that all KPIs are positive in terms of the economic feasibility of the proposed project. The ENPV is substantial USD 8,822,886 and the EIRR is at 81%, significantly higher than the used discount rate of 5% making this measure, under presented assumptions, highly economically viable.

Sensitivity analysis

60. Various scenarios were tested to establish the economic viability of measure 4 based on either changes in the costs of investment or changes in the level of benefits. The results are presented in the following table.

Table 17 Sensitivity analysis for measure 4.

Project costs	ENPV of the investment	EIRR of the investment
60%	$9,493,086	135%
80%	$9,157,986	101%
100%	$8,822,886	81%
120%	$8,487,786	67%

140%	$8,152,686	57%
Benefits	**ENPV of the investment**	**EIRR of the investment**
60%	$4,623,532	48%
80%	$6,723,209	64%
100%	$8,822,886	81%
120%	$10,922,563	97%
140%	$13,022,240	114%

61. The results show a positive ENPV and EIRR in all scenarios with alternating level of costs and income, respectively. Based on the assumptions described above, measure 4. can be justified on economic grounds.

2.6. Consolidated project level cost/benefit analysis

62. An economic analysis of the project as a whole has been performed to assess the incremental adaptation benefits to climate change. This analysis combines all four measures, scaled-up to the envisaged level of investment designated per measure within the Annex project budget. Additionally, the project-level analysis takes into account the entire proposed project budget including the costs of all the components (i.e. non-investment components as well) and project management costs and co-finance. Please note that none of co-finance is envisaged for investments covered by this economic analysis.

Results

63. The following table presents the project level cost-benefit analysis that consolidates all four previously elaborated adaptation measures and includes the non-investment part of the programme budget. The discount rate of 5% used was the same as throughout the entire analysis.

Table 18 Consolidated economic analysis – entire project

Label	Unit	Source of information	Total
Year			
Costs - (OPEX costs - leveraged co-finance)			
M1 - CAPEX costs	USD	M1 - Coastal management	$ 1,629,162
M1 - OPEX costs	USD	M1 - Coastal management	$ 174,218
M2 - CAPEX costs	USD	M2 - Coastal management	$ 2,008,916
M2 - OPEX costs	USD	M2 - Coastal management	$ 2,632,500
M3 - CAPEX costs	USD	M3 - Climate Resilient Agri	$ 1,680,000
M3 - OPEX costs	USD	M3 - Climate Resilient Agri	$ 3,780,000
M4 - CAPEX costs	USD	M4-Processing and storage	$ 1,939,600
M4 - OPEX costs	USD	M4-Processing and storage	$ -
Total CAPEX	USD	Total	$ 7,257,678
Total OPEX	USD	Total	$ 6,586,718
Total	**USD**	**Calculated**	**$ 13,844,000**

Other project costs			
Total project costs GCF+co-finance	USD	Annex budget file	$ 32,650,440

Total CAPEX	USD	Calculated	$ 7,257,678
Total non-investment project costs GCF+co-finance	USD	Calculated	$ 25,392,762
Total non-investment project costs GCF+co-finance	**USD**	**Calculated**	**$ 25,392,762**

Total costs (including OPEX as leveraged co-finance)	**USD**	**Calculated**	**$ 42,237,158**

Benefits			
M1 - benefits	USD	M1 - EWS Communication equipment	$ 6,614,472
M2 - benefits	USD	M2 - Coastal management	$ 7,462,463
M3 - benefits	USD	M3 - Climate Resilient Agri	$ 12,683,639
M4 - benefits	USD	M4-Processing and storage	$ 15,738,941
Total benefits	**USD**	**Calculated**	**$ 36,000,000**

Table 19 KPIs - Project level

Net costs / benefits	USD	**Calculated**	**$ 9,388,555**
EIRR	%	**Calculated**	**3%**
ENPV	**USD**	**Calculated**	**$ 9,388,555**
Net costs / benefits per year	**USD / year**	**Calculated**	**$ 234,714**

64. The results show a slightly positive, however, lower than discount rate, ENPV and EIRR. This is due to the need for significant investments in capacity building and other non-investment costs in order to ensure the project's adaptation investments are implemented within a supportive enabling environment, have sufficient technical support for effective implementation, and include sufficient institutional capacity building to ensure the benefits are sustainable in the longer term. Essentially, these investments are necessary to catalyse a paradigm shift in resilience in Vanuatu. While the full project shows a just slightly positive economic return on investment, each specific investment shows a high rate of return on investment and the non-investment costs will ensure the project leaves a substantial legacy of capacity for sustainability and more effective allocation and utilisation of future flows of climate finance.

2.7. Findings

65. The report shows that **all four of the adaptation measures analysed have either a very high or high economic internal rate of return and can be justified on economic grounds**. The analysis shows that the selected measures will have a significantly positive economic impact for the targeted communities over the life of the project and beyond.

66. The report also undertook assessment of the incremental adaptation benefits of the four selected measures in the context of the overall project budget. This analysis showed the project has an EIRR of 3%, which is below the discount rate. This is directly due to the size of the non-investment flows required to enable and support the adaptation investments, to ensure their long-term sustainability and to catalyse a paradigm shift in resilience in Vanuatu. However, **the analysis found that the project still presents a strong investment for the GCF**. An economic analysis cannot assess the non-economic,

non-investment components of the project and, therefore, shows a neutral/slightly positive 3% EIRR. This does not imply a shortcoming of the project or its direct economic benefits, which, on a per-investment basis, are strongly positive. Rather it highlights some incompatibility of this method of assessment for projects delivering adaptation action in highly resource constrained and low-capacity contexts.

67. There are three key reasons why the project budget includes significant non-economically assessable costs (non-investment costs):

    1. The need to address significant capacity gaps and constraints at all levels (government at national, provincial and Area Council levels as well as at the community level) that undermine the effective development and implementation of adaptation actions – particularly in highly climate vulnerable rural and remote communities – and prevent the generation of a paradigm shift in resilience. The project's first component is focused on building institutional capacity at the local level to ensure that the project's adaptation investments (delivered via the adaptation package menu under Component 2) are feasible and are implemented in a strong enabling environment. Without these additional investments, the adaptation investments would be unlikely to be successful.

    2. The need to ensure that the project leaves behind significantly increased institutional capacity to increase the sustainability and replicability of the project's adaptation investments and catalyse transformation. National and provincial capacity to support ongoing adaptation action in the targeted communities is vital, and investments under Component 3 of the project focus on this element, as well as helping ensure that the government has the capacity to scale up and replicate these adaptation investments in communities not targeted by the project.

    3. The high cost of delivering projects in Pacific SIDS. It is important to note that implementing projects in Pacific SIDS entails higher costs than in many other developing countries, as the 'combination of extreme remoteness from major markets, very small size, dispersion over vast tracts of the Pacific Ocean, and environmental fragility results in very high cost of production of goods and services by both the private and public sector.'[3] This project explicitly aims to reach the most climate vulnerable communities in Vanuatu to generate a paradigm shift in their resilience. These communities are often in the most remote and geographically challenging parts of the country, requiring significant logistical undertakings to bring people and goods to them. This also explains why the technical assistance and travel cost of the project is high compared to the investment costs.

68. While the types of benefits these activities generate are often non-monetary and have the characteristics of public goods (which are often challenging to quantify for any credible economic analysis), without these activities the project's economically quantifiable adaptation investments would be significantly less impactful in the immediate term, would be less sustainable in the longer term and would fail to generate transformational change.

[3] *World Bank (2017) Pacific Possible. Available here.*

3. Financial analysis

69. The project focuses exclusively on subsistence related beneficiaries. Given that most of the interventions planned are public sector projects that use grant funding and therefore do not generate any revenues, a financial analysis is largely infeasible. Given this, a focus has been put on the economic analysis of the project. Generally, these types of investments produce outputs and outcomes that meet the classical definition of public goods (non-rivalrous and non-excludable)4.

70. The project is financed by grants (either from GCF or co-financing sources) and all activities covered with investments target subsistence production. However, there are two types of investments that, in theory, could result in revenue-generating impact – production aspects under climate smart agriculture and food processing and storage.

3.1. Approach

71. Illustrative financial analysis at the business level was conducted for several types of interventions that are complementary with the economic analysis (chapter 2). Those were identified as the most probable interventions under Component 2. These are envisaged under Measures 3 and 4 and are tested by cost/benefit analysis under “with project scenario” in the context of achieved resilience. The interventions include:

- **Measure 3: Climate resilient agriculture – taro production**
- **Measure 3: Climate resilient agriculture – yam production**
- **Measure 4: Food processing and storage – copra dryers**
- **Measure 4: Food processing and storage – solar freezers**

72. The financial analysis was undertaken by testing a single business level performance against financial cost benefit analysis in several scenarios:

- Scenario 1: Activities implemented without GCF grant using commercial loan
- Scenario 2: Activities implemented with the GCF grant and commercial loan
- Scenario 3: Activities implemented with the GCF grant only

3.2. Measure 3: Climate resilient agriculture – production of taro

73. Full description of the measure under 2.4.

Assumptions

74. The financial analysis at the single business level was conducted and tested under three scenarios and the lifetime of investment of 20 years.

Table 20 Assumptions for measure 3 – taro production.

Taro production Inputs for the financial analysis			
Average yield per ha	http://www.fao.org/3/AC450E/ac450e05.htm	tonnes per ha	6.2
Value per tonne of yield	https://core.ac.uk/download/pdf/223128647.pdf	USD/tonne	$150
Marginal investment costs	Assumption + cost for soil conservation interventions	USD/ha/a	$2,000

[4] Non-rivalrous goods are public goods that are consumed by people but whose supply is not affected by people’s consumption. In other words, when an individual or a group of individuals use a particular good, the supply left for other people to use remains unchanged. Therefore, non-rivalrous goods can be consumed over and over again without the fear of depletion of supply.

Marginal operating costs	Assumption	USD/ha/a	$250
Average size of taro production farm in Vanuatu	Assumption	ha	1
Annual average cumulative losses due to climate change impacts - average	Assumption - economic analysis under this annex	%	13%
Net annual yield per one farm in Vanuatu - available for sale	**Calculated**	**tonne/annum**	**5**
Annual income per one farm	**Calculated**	**USD/a**	**$809**

Results

Table 21 Scenario 1 - without GCF grant using commercial loan

Scenario 1 - only commercial loan financing			
Parameter	**Source**	**Unit**	**Total**
Total investment cost (including OPEX costs for the first production year)	**Calculated**	$2,250	
Own funds	**Assumption**	**0%**	0
Grant	**Assumption**	**0%**	0
	Loan calculation		
Maturity period	**Assumption**	**year**	**8**
Credit interest rate	**Assumption**	**%**	**10.0%**
Bank fees	**Assumption**	**%**	**1.0%**

Balance brought forward	Calculated	**USD**	
Drawdown	Calculated	**USD**	2,250
Bank fees	Calculated	**USD**	23
Principle repayment	Calculated	**USD**	-2,273
Interest repayment	Calculated	**USD**	-1,135
Total debt service	**Calculated**	**USD**	**-3,408**
	Sales		
Income from sales	**Calculated**	**USD/a**	809
Cash flow	**Calculated**	**USD**	2,729
Payback period - in month		**121.4**	
Payback period - in years		**10.1**	

Annual OPEX costs		**USD/a**	250

Discount rate	
WACC Based on lending interest rate level offered by local commercial banks (https://www.theglobaleconomy.com/Vanuatu/lending_interest_rate/)	10%

		Total
NPV (20 years)		**-497 €**
IRR (Leveraged - 20 years)		**9.7%**

Monthly credit repayment (total)		$35.50
Monthly income from sales		$67.43
Household income at median level	HOUSEHOLD INCOME & EXPENDITURE 2019–2020 NSDP Baseline Survey	$720
Monthly credit as a percentage of income		4.9%

Table 22 the GCF grant and commercial loan

Scenario 2 - GCF grant + commercial loan			
Parameter	**Source**	**Unit**	**Total**
Total investment cost (including OPEX costs for the first production year)	**Calculated**	$2,250	
Own funds	**Assumption**	**0%**	0
Grant	**Assumption**	**30%**	675
Loan calculation			
Maturity period	**Assumption**	**year**	**8**
Credit interest rate	**Assumption**	**%**	**10.0%**
Bank fees	**Assumption**	**%**	**1.0%**
Balance brought forward	Calculated	**USD**	
Drawdown	Calculated	**USD**	1,575
Bank fees	Calculated	**USD**	16
Principle repayment	Calculated	**USD**	-1,591
Interest repayment	Calculated	**USD**	-795
Total debt service	**Calculated**	**USD**	**-2,385**
Sales			
Income from sales	**Calculated**	**USD/a**	**809**
Cash flow	**Calculated**	**USD**	3,751
Payback period - in month		**99.5**	
Payback period - in years		**8.3**	

Annual OPEX costs		**USD/a**	250

Discount rate	
WACC Based on lending interest rate level offered by local commercial banks (https://www.theglobaleconomy.com/Vanuatu/lending_interest_rate/)	10%

NPV (20 years)		**Total**
		253 €
IRR (Leveraged - 20 years)		**13.1%**

Monthly credit repayment (total)		$ 24.85
Monthly income from sales		$ 67.43
Household income at median level	HOUSEHOLD INCOME & EXPENDITURE 2019–2020 NSDP Baseline Survey	$ 720
Monthly credit as a percentage of income		3.5%

Table 23 – Scenario 3 – the GCF grant only

Scenario 3 - GCF grant only			
Parameter	**Source**	**Unit**	**Total**
Total investment cost (including OPEX costs for the first production year)	**Calculated**	$2,250	
Own funds	**Assumption**	**0%**	0
Grant	**Assumption**	**100%**	2,250
Loan calculation			
Maturity period	**Assumption**	**year**	**8**
Credit interest rate	**Assumption**	**%**	**10.0%**
Bank fees	**Assumption**	**%**	**1.0%**

Balance brought forward	Calculated	**USD**	
Drawdown	Calculated	**USD**	0
Bank fees	Calculated	**USD**	0
Principle repayment	Calculated	**USD**	0
Interest repayment	Calculated	**USD**	0
Total debt service	**Calculated**	**USD**	**0**
Sales			
Income from sales	**Calculated**	**USD/a**	**809**
Cash flow	**Calculated**	**USD**	6,137
Payback period - in month		**48.3**	
Payback period - in years		**4.0**	

Annual OPEX costs		**USD/a**	250

Discount rate	
WACC	10%

Based on lending interest rate level offered by local commercial banks (https://www.theglobaleconomy.com/Vanuatu/lending_interest_rate/)	

NPV (20 years)		Total
		2,003 €
IRR (Non-leveraged - 20 years)		24.5%

75. The results showcase that KPIs are positive for scenarios where the GCF grant is included. The scenario where only commercial loan is used results in IRR slightly below the WACC – 9.7% and with the negative NPV of -497 USD. This clearly shows that it would not be feasible to finance taro production under commercial loan terms available in Vanuatu.

Sensitivity analysis

76. The following presents two types of sensitivity analysis.

- The first sensitivity describes KPIs performance when different level of grant is provided and blended alongside loan funds lent under commercial terms.
- The second sensitivity analysis describes performance of KPIs when different level of interest rate is applied. The purpose of this analysis is to understand the financial performance of an investment under different concessional loan terms, such us the GCF loan financing.

Table 24 Grant level impact to KPIs (leveraged) – taro production

Grant	NPV	Leveraged IRR
0%	-€ 497	9.7%
10%	-€ 247	10.7%
20%	€ 3	11.9%
30%	€ 253	13.1%
40%	€ 503	14.4%
50%	€ 753	15.7%
60%	€ 1,003	17.2%
70%	€ 1,253	18.9%
80%	€ 1,503	20.6%
90%	€ 1,753	22.5%
100%	€ 2,003	24.5%

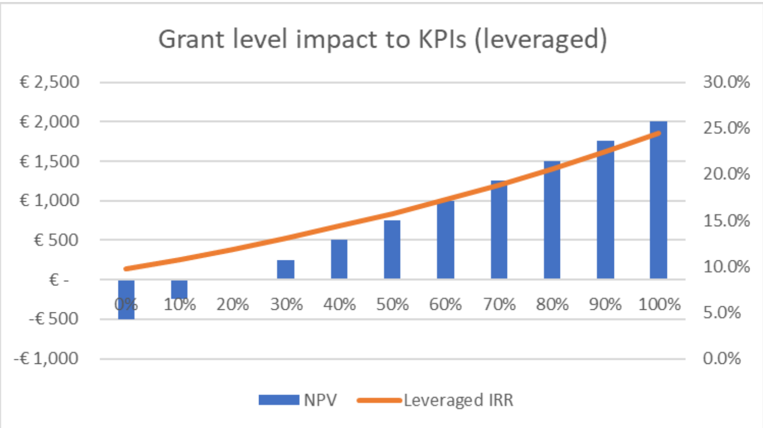

Figure 1 Grant level impact to KPIs (leveraged) – taro production

77. The results presents that grant amount of 30% and more results in favourable KPIs.

Table 25 Interest rate level impact to KPIs (No grant)

Interest rate	NPV	Leveraged IRR
1%	€ 298	13.3%
2%	€ 182	12.7%
3%	€ 103	12.3%
4%	€ 22	12.0%
5%	-€ 61	11.6%
6%	-€ 145	11.2%
7%	-€ 231	10.8%
8%	-€ 318	10.4%
9%	-€ 407	10.1%
10%	-€ 497	9.7%
11%	-€ 589	9.3%
12%	-€ 682	9.0%

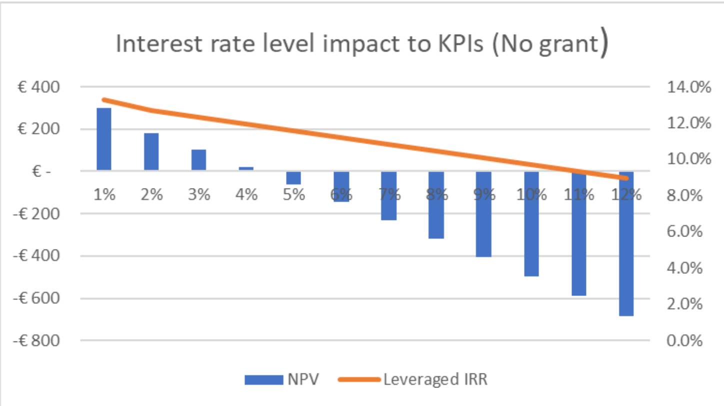

Figure 2 Interest rate level impact to KPIs (No grant included) – taro production

3.3. Measure 3: Climate resilient agriculture – production of yam

78. Full description of the measure under 2.4.

<u>Assumptions</u>

79. The financial analysis at the single business level was conducted and tested under three scenarios and the lifetime of investment of 20 years.

80. Table 26 Assumptions for measure 3 – yam production.

Yam production Inputs for the financial analysis			
Average yield per ha	http://www.fao.org/3/AC450E/ac450e05.htm	tonnes per ha	8

Value per tonne of yield	https://core.ac.uk/download/pdf/223128647.pdf	USD/tonne	$150
Marginal investment costs	Assumption + cost for soil conservation interventions	USD/ha/a	$2,000
Marginal operating costs	Assumption	USD/ha/a	$250
Average size of yam production farm in Vanuatu	Assumption	ha	$1
Annual average cumulative losses due to climate change impacts - average	Assumption - economic analysis under this annex	%	13%
Net annual yield per one farm in Vanuatu - available for sale	**Calculated**	**tonne/annum**	**7**
Annual income per one farm	**Calculated**	**USD/a**	**$1,044**

Results

Table 27 Scenario 1 - without GCF grant using commercial loan

Scenario 1 - only commercial loan financing			
Parameter	**Source**	**Unit**	**Total**
Total investment cost (including OPEX costs for the first production year)	**Calculated**	$2,250	
Own funds	**Assumption**	**0%**	0
Grant	**Assumption**	**0%**	0
Loan calculation			
Maturity period	**Assumption**	**year**	**8**
Credit interest rate	**Assumption**	**%**	**10.0%**
Bank fees	**Assumption**	**%**	**1.0%**

Balance brought forward	Calculated	**USD**	
Drawdown	Calculated	**USD**	2,250
Bank fees	Calculated	**USD**	23
Principle repayment	Calculated	**USD**	-2,273
Interest repayment	Calculated	**USD**	-1,135
Total debt service	**Calculated**	**USD**	**-3,408**
Sales			
Income from sales	**Calculated**	**USD/a**	1,044
Cash flow	**Calculated**	**USD**	6,252
Payback period - in month		**85.5**	
Payback period - in years		**7.1**	

Annual OPEX costs		**USD/a**	250

Discount rate	
WACC Based on lending interest rate level offered by local commercial banks(https://www.theglobaleconomy.com/Vanuatu/lending_interest_rate/)	10%

		Total
NPV (20 years)		**1,289 €**
IRR (Leveraged - 20 years)		**17.5%**

Monthly credit repayment (total)		$35.50
Monthly income from sales		$87.00
Household income at median level	HOUSEHOLD INCOME & EXPENDITURE 2019–2020 NSDP Baseline Survey	$720
Monthly credit as a percentage of income		4.9%

Table 28 the GCF grant and commercial loan

Scenario 2 - GCF grant + commercial loan			
Parameter	**Source**	**Unit**	**Total**
Total investment cost (including OPEX costs for the first production year)	**Calculated**	$2,250	
Own funds	**Assumption**	**0%**	0
Grant	**Assumption**	**30%**	675
Loan calculation			
Maturity period	**Assumption**	**year**	**8**
Credit interest rate	**Assumption**	**%**	**10.0%**
Bank fees	**Assumption**	**%**	**1.0%**

Balance brought forward	Calculated	**USD**	
Drawdown	Calculated	**USD**	1,575
Bank fees	Calculated	**USD**	16
Principle repayment	Calculated	**USD**	-1,591
Interest repayment	Calculated	**USD**	-795
Total debt service	**Calculated**	**USD**	**-2,385**
Sales			
Income from sales	**Calculated**	**USD/a**	1,044
Cash flow	**Calculated**	**USD**	7,275
Payback period - in month		**61.7**	
Payback period - in years		**5.1**	

Annual OPEX costs		**USD/a**	250

Discount rate	
WACC Based on lending interest rate level offered by local commercial banks (https://www.theglobaleconomy.com/Vanuatu/lending_interest_rate/)	10%

		Total
NPV (20 years)		**2,039 €**
IRR (Leveraged - 20 years)		**21.7%**

Monthly credit repayment (total)		$24.85
Monthly income from sales		$87.00
Household income at median level	HOUSEHOLD INCOME & EXPENDITURE 2019–2020 NSDP Baseline Survey	$720
Monthly credit as a percentage of income		3.5%

Table 29 – Scenario 3 – the GCF grant only

Scenario 3 - GCF grant only			
Parameter	**Source**	**Unit**	**Total**
Total investment cost (including OPEX costs for the first production year)	**Calculated**	$2,250	
Own funds	**Assumption**	**0%**	0
Grant	**Assumption**	**100%**	2,250
Loan calculation			
Maturity period	**Assumption**	**year**	**8**
Credit interest rate	**Assumption**	**%**	**10.0%**
Bank fees	**Assumption**	**%**	**1.0%**
Balance brought forward	Calculated	**USD**	
Drawdown	Calculated	**USD**	0
Bank fees	Calculated	**USD**	0
Principle repayment	Calculated	**USD**	0
Interest repayment	Calculated	**USD**	0
Total debt service	**Calculated**	**USD**	**0**
Sales			
Income from sales	**Calculated**	**USD/a**	1,044
Cash flow	**Calculated**	**USD**	9,660
Payback period - in month		**34.0**	
Payback period - in years		**2.8**	

Annual OPEX costs		**USD/a**	250

Discount rate	
WACC Based on lending interest rate level offered by local commercial banks (https://www.theglobaleconomy.com/Vanuatu/lending_interest_rate/)	10.00%

		Total
NPV (20 years)		**3,789 €**
IRR (Non-leveraged - 20 years)		**35.2%**

81. The results showcase that KPIs are positive for all scenarios. The amount of grant has significant influence to profitability and is significantly increasing in line with grant increase.

Sensitivity analysis

82. The following presents two types of sensitivity analysis.

- The first sensitivity describes KPIs performance when different level of grant is provided and blended alongside loan funds lent under commercial terms.
- The second sensitivity analysis describes performance of KPIs when different level of interest rate is applied. The purpose of this analysis is to understand the financial performance of an investment under different concessional loan terms, such us the GCF loan financing.

Table 30 Grant level impact to KPIs (leveraged) – yam production

Grant	NPV	Leveraged IRR
0%	€ 1,289	17.5%
10%	€ 1,539	18.8%
20%	€ 1,789	20.2%
30%	€ 2,039	21.7%
40%	€ 2,289	23.3%
50%	€ 2,539	24.9%
60%	€ 2,789	26.7%
70%	€ 3,039	28.7%
80%	€ 3,289	30.7%
90%	€ 3,539	32.9%
100%	€ 3,789	35.2%

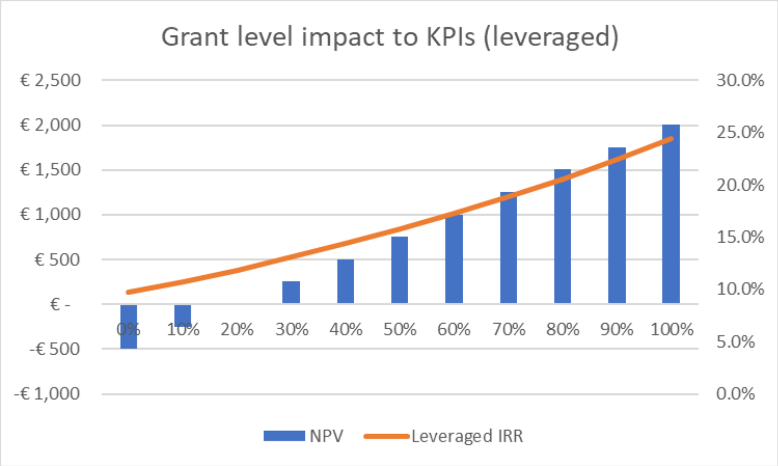

Figure 3 Grant level impact to KPIs (leveraged) – yam production

Table 31 Interest rate level impact to KPIs (No grant) – yam production

Interest rate	NPV		Leveraged IRR
1%	€	2,085	21.9%
2%	€	1,969	21.2%
3%	€	1,889	20.8%
4%	€	1,808	20.3%
5%	€	1,726	19.8%
6%	€	1,642	19.4%
7%	€	1,556	18.9%
8%	€	1,469	18.4%
9%	€	1,380	18.0%
10%	€	1,289	17.5%
11%	€	1,198	17.1%
12%	€	1,105	16.6%

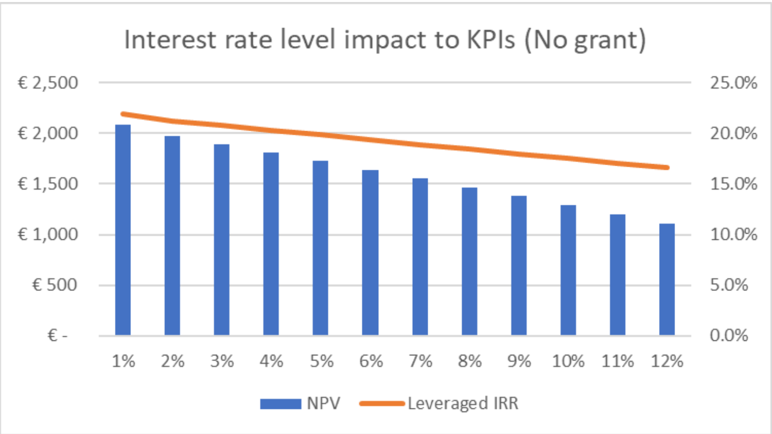

Figure 4 Interest rate level impact to KPIs (No grant included) – yam production

83. The results within both sensitivity analysis shows that yam production is profitable in all scenarios.

3.4. Measure 4: Food processing and storage – copra dryers

84. Full description of the measure under 2.4.

Assumptions

85. The financial analysis at the single business level was conducted and tested under three scenarios and the lifetime of investment of 10 years.

Table 32 Assumptions for measure 4 – copra dryers

Copra dryers Inputs for the financial analysis			
Investment lifetime	Assumption	Years	10
Investment costs per one solar dryer	Annex budget file	USD	$5,900
Energy consumption of one copra solar dryer	https://energypedia.info/wiki/Solar_Drying	kWh/day	60
Cost of feedstock - Processor perspective	Assumption based on https://www.pna.gov.ph/articles/1142268	USD/kg	$0.3
Copra batch size	https://www.sciencedirect.com/science/article/pii/S0301479720306629	kg	500
Copra reduction in mass - deducted moisture	https://www.sciencedirect.com/science/article/pii/S0301479720306629	%	50%
Solar dryer - annual operating days	https://www.sciencedirect.com/science/article/pii/S0301479720306629	days	250
Duration of drying - per batch	Assumption based on https://www.sciencedirect.com/science/article/pii/S0301479720306629	days	20
Number of batches per annum	Calculated	#/a	13
Amount of copra processed (dried) - per annum	Calculated	kg/a	3,125
Amount of coconut oil per one kg of copra	https://documents1.worldbank.org/curated/en/309941468180567229/pdf/FAU4.pdf	kg/kg	0.61
Annual coconut oil potential per one solar dryer	Calculated	kg	5,123
Annual solar energy consumption	Calculated	kWh/a	15,000
Value of coconut oil - food security increase	Assumption based on https://www.tridge.com/intelligences/coconut-oil/price	USD	$1
Annual cost of feedstock	**Calculated**	**USD/a**	**$1,563**
Net annual coconut oil yield per one copra drier	**Calculated**	**kg/a**	**5,123**
Annual income per one drier	**Calculated**	**USD/a**	**$5,123**

Results

Table 33 Scenario 1 - without GCF grant using commercial loan

Scenario 1 - only commercial loan financing			
Parameter	**Source**	**Unit**	**Total**
Total investment cost	**Calculated**	$5,900	
Own funds	**Assumption**	**0%**	0
Grant	**Assumption**	**0%**	0
Loan calculation			
Maturity period	**Assumption**	**year**	**5**
Credit interest rate	**Assumption**	**%**	**10.0%**
Bank fees	**Assumption**	**%**	**1.0%**

Balance brought forward	Calculated	**USD**	
Drawdown	Calculated	**USD**	5,900
Bank fees	Calculated	**USD**	59
Principle repayment	Calculated	**USD**	-5,959
Interest repayment	Calculated	**USD**	-1,901
Total debt service	**Calculated**	**USD**	**-7,860**
Sales			
Income from sales	**Calculated**	**USD/a**	5,123
Cash flow	**Calculated**	**USD**	18,284
Payback period - in month		**45.1**	
Payback period - in years		**3.8**	

Annual feedstock price		**USD/year**	1,563

Discount rate	
WACC Based on lending interest rate level offered by local commercial banks (https://www.theglobaleconomy.com/Vanuatu/lending_interest_rate/)	10%

		Total
NPV (10 years)		**8,050 €**
IRR (Leveraged - 10 years)		**29.4%**

Monthly credit repayment (total)	$131.00
Monthly income from sales	$426.91

Household income at median level	HOUSEHOLD INCOME & EXPENDITURE 2019–2020 NSDP Baseline Survey	$720
Monthly credit as a percentage of income		18.2%

Table 34 the GCF grant and commercial loan

Scenario 2 - GCF grant + commercial loan			
Parameter	**Source**	**Unit**	**Total**
Total investment cost	**Calculated**	$5,900	
Own funds	**Assumption**	**0%**	0
Grant	**Assumption**	**30%**	1,770
Loan calculation			
Maturity period	**Assumption**	**year**	**5**
Credit interest rate	**Assumption**	**%**	**10.0%**
Bank fees	**Assumption**	**%**	**1.0%**
Drawdown	Calculated	**USD**	4,130
Bank fees	Calculated	**USD**	41
Principle repayment	Calculated	**USD**	-4,171
Interest repayment	Calculated	**USD**	-1,331
Total debt service	**Calculated**	**USD**	**-5,502**
Sales			
Income from sales	**Calculated**	**USD/a**	5,123
Cash flow	**Calculated**	**USD**	20,642
Payback period - in month		**34.1**	
Payback period - in years		**2.8**	

Annual OPEX costs		**USD/a**	1,563

Discount rate	
WACC Based on lending interest rate level offered by local commercial banks (https://www.theglobaleconomy.com/Vanuatu/lending_interest_rate/)	10%

		Total
NPV (20 years)		**10,016 €**
IRR (Leveraged - 20 years)		**36.6%**

Monthly credit repayment (total)		$91.70
Monthly income from sales		$426.91
Household income at median level	HOUSEHOLD INCOME & EXPENDITURE 2019–2020 NSDP Baseline Survey	$720

Monthly credit as a percentage of income	12.7%

Table 35 – Scenario 3 – the GCF grant only

Scenario 3 - GCF grant only			
Parameter	**Source**	**Unit**	**Total**
Total investment cost	**Calculated**	$5,900	
Own funds	**Assumption**	**0%**	0
Grant	**Assumption**	**100%**	5,900
Loan calculation			
Maturity period	**Assumption**	**year**	**5**
Credit interest rate	**Assumption**	**%**	**10.0%**
Bank fees	**Assumption**	**%**	**1.0%**
Balance brought forward	Calculated	**USD**	
Drawdown	Calculated	**USD**	0
Bank fees	Calculated	**USD**	0
Principle repayment	Calculated	**USD**	0
Interest repayment	Calculated	**USD**	0
Total debt service	**Calculated**	**USD**	**0**
Sales			
Income from sales	**Calculated**	**USD/a**	5,123
Cash flow	**Calculated**	**USD**	26,144
Payback period - in month		**19.9**	
Payback period - in years		**1.7**	
Annual OPEX costs		**USD/a**	1,563

Discount rate	
WACC Based on lending interest rate level offered by local commercial banks (https://www.theglobaleconomy.com/Vanuatu/lending_interest_rate/)	10.00%

NPV (10 years)		**Total** **14,605 €**
IRR (Non-leveraged - 10 years)		**59.4%**

86. The results showcase that KPIs are positive for all scenarios. The amount of grant has significant influence to profitability and is significantly increasing in line with grant increase.

Sensitivity analysis

87. The following presents two types of sensitivity analysis.

- The first sensitivity describes KPIs performance when different level of grant is provided and blended alongside loan funds lent under commercial terms.
- The second sensitivity analysis describes performance of KPIs when different level of interest rate is applied. The purpose of this analysis is to understand the financial performance of an investment under different concessional loan terms, such us the GCF loan financing.

Table 36 Grant level impact to KPIs (leveraged) – copra dryers

Grant	NPV	Leveraged IRR
0%	€ 8,050	29.4%
10%	€ 8,705	31.7%
20%	€ 9,361	34.1%
30%	€ 10,016	36.6%
40%	€ 10,672	39.3%
50%	€ 11,327	42.1%
60%	€ 11,983	45.2%
70%	€ 12,638	48.4%
80%	€ 13,294	51.9%
90%	€ 13,949	55.5%
100%	€ 14,605	59.4%

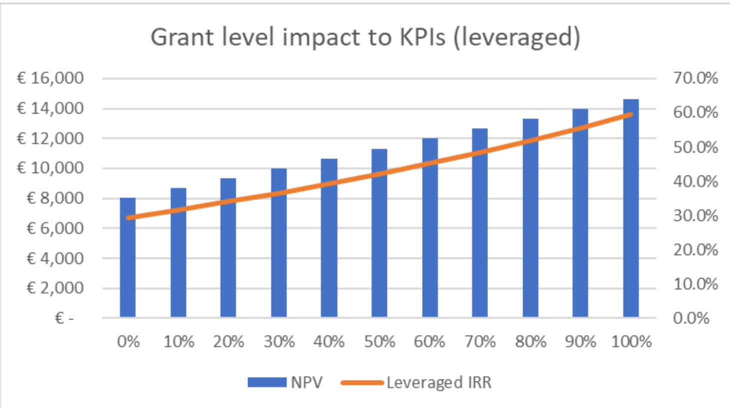

Figure 5 Grant level impact to KPIs (leveraged) – copra dryers

Table 37 Interest rate level impact to KPIs (No grant) – copra dryers

Interest rate	NPV	Leveraged IRR
1%	€ 9,560	34.8%
2%	€ 9,333	34.0%
3%	€ 9,179	33.4%
4%	€ 9,023	32.8%
5%	€ 8,865	32.2%
6%	€ 8,706	31.7%
7%	€ 8,544	31.1%
8%	€ 8,381	30.6%
9%	€ 8,216	30.0%
10%	€ 8,050	29.4%

Interest rate	NPV		Leveraged IRR
11%	€	7,882	28.9%
12%	€	7,712	28.3%

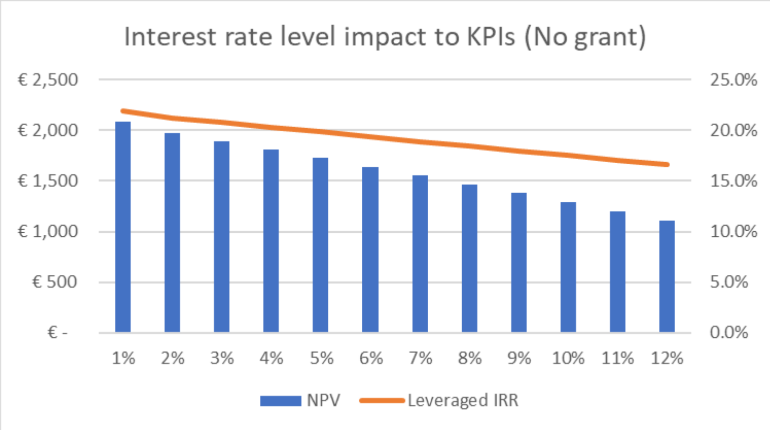

Figure 6 Interest rate level impact to KPIs (No grant included) – copra dryers

88. The results within both sensitivity analysis shows that copra dryers are profitable in all scenarios.

3.5. Measure 4: Food processing and storage – solar freezers

89. Full description of the measure under 2.4.

Assumptions

90. The financial analysis at the single business level was conducted and tested under three scenarios and the lifetime of investment of 10 years.

Table 38 Assumptions for measure 4 – solar freezers

Solar freezer Inputs for the financial analysis			
Investment lifetime	Assumption	Years	10
Investment costs per one solar dryer	Annex budget file	USD	$5,915
Cost of feedstock - Processor perspective	Assumption	USD/ kg	$0.0
Refrigeration capacity per unit	Assumption	kg	200
Number of refrigeration batches/round per year	Assumption	#	2
Amount of copra processed (dried) - per annum	Calculated	kg/a	400
Value of fish refrigerated - per kg	https://malffb.gov.vu/doc/fisheries/Aquaculture%20Development%20Plan.pdf	USD	$4
Annual cost of feedstock	**Calculated**	**USD/ a**	$0
Annual income per one drier	**Calculated**	**USD/ a**	**$1,600**

Results

Table 39 Scenario 1 - without GCF grant using commercial loan

Scenario 1 - only commercial loan financing			
Parameter	**Source**	**Unit**	**Total**
Total investment cost	**Calculated**	$5,915	
Own funds	**Assumption**	**0%**	0
Grant	**Assumption**	**0%**	0
Loan calculation			
Maturity period	**Assumption**	**year**	**5**
Credit interest rate	**Assumption**	**%**	**10.0%**
Bank fees	**Assumption**	**%**	**1.0%**

Balance brought forward	Calculated	**USD**	
Drawdown	Calculated	**USD**	5,915
Bank fees	Calculated	**USD**	59
Principle repayment	Calculated	**USD**	-5,974
Interest repayment	Calculated	**USD**	-1,906
Total debt service	**Calculated**	**USD**	**-7,880**
Sales			
Income from sales	**Calculated**	**USD/a**	1,600
Cash flow	**Calculated**	**USD**	605
Payback period - in month		**103.5**	
Payback period - in years		**8.6**	
Discount rate			
WACC Based on lending interest rate level offered by local commercial banks (https://www.theglobaleconomy.com/Vanuatu/lending_interest_rate/)		10%	

NPV (10 years)		**Total**
		-3,272 €
IRR (Leveraged - 10 years)		**1.1%**

Monthly credit repayment (total)		$131.33
Monthly income from sales		$133.33
Household income at median level	HOUSEHOLD INCOME & EXPENDITURE 2019–2020 NSDP Baseline Survey	$720
Monthly credit as a percentage of income		18.2%

Table 40 the GCF grant and commercial loan

Scenario 2 - GCF grant + commercial loan			
Parameter	**Source**	**Unit**	**Total**
Total investment cost	**Calculated**	$5,915	
Own funds	**Assumption**	**0%**	0
Grant	**Assumption**	**30%**	1,775
Loan calculation			
Maturity period	**Assumption**	**year**	**5**
Credit interest rate	**Assumption**	**%**	**10.0%**
Bank fees	**Assumption**	**%**	**1.0%**
Balance brought forward	Calculated	**USD**	
Drawdown	Calculated	**USD**	4,141
Bank fees	Calculated	**USD**	41
Principle repayment	Calculated	**USD**	-4,182
Interest repayment	Calculated	**USD**	-1,334
Total debt service	**Calculated**	**USD**	**-5,516**
Sales			
Income from sales	**Calculated**	**USD/a**	1,600
Cash flow	**Calculated**	**USD**	2,969
Payback period - in month		**85.7**	
Payback period - in years		**7.1**	
Discount rate			
WACC Based on lending interest rate level offered by local commercial banks (https://www.theglobaleconomy.com/Vanuatu/lending_interest_rate/)		10%	

NPV (10 years)		**Total** **-1,301 €**
IRR (Leveraged - 10 years)		**6.1%**

Monthly credit repayment (total)		$91.93
Monthly income from sales		$133.33
Household income at median level	HOUSEHOLD INCOME & EXPENDITURE 2019–2020 NSDP Baseline Survey	$720
Monthly credit as a percentage of income		12.8%

Table 41 – Scenario 3 – the GCF grant only

Scenario 3 - GCF grant only			
Parameter	**Source**	**Unit**	**Total**
Total investment cost (including OPEX costs for the first production year)	**Calculated**	$5,915	
Own funds	**Assumption**	**0%**	0
Grant	**Assumption**	**100%**	5,915
Loan calculation			
Maturity period	**Assumption**	**year**	**8**
Credit interest rate	**Assumption**	**%**	**10.0%**
Bank fees	**Assumption**	**%**	**1.0%**

Balance brought forward	Calculated	**USD**	
Drawdown	Calculated	**USD**	0
Bank fees	Calculated	**USD**	0
Principle repayment	Calculated	**USD**	0
Interest repayment	Calculated	**USD**	0
Total debt service	**Calculated**	**USD**	**0**
Balance carried forward	**Calculated**	**USD**	
Sales			
Income from sales	**Calculated**	**USD/a**	1,600
Cash flow	**Calculated**	**USD**	8,485
Cumulative Cash Flow		**USD**	
Payback period - in month		**44.4**	
Payback period - in years		**3.7**	
Discount rate			
WACC Based on lending interest rate level offered by local commercial banks (https://www.theglobaleconomy.com/Vanuatu/lending_interest_rate/)		10.00%	

NPV (10 years)		**Total** **3,299 €**
IRR (Non-leveraged - 10 years)		**22.8%**

The financial analysis for solar freezers results in unfavourable KPIs in case loan financing is applied. The grant of 50% or higher is required to make financial investment profitable.

<u>Sensitivity analysis</u>

91. The following presents two types of sensitivity analysis.

- The first sensitivity describes KPIs performance when different level of grant is provided and blended alongside loan funds lent under commercial terms.
- The second sensitivity analysis describes performance of KPIs when different level of interest rate is applied. The purpose of this analysis is to understand the financial performance of an investment under different concessional loan terms, such us the GCF loan financing.

Table 42 Grant level impact to KPIs (leveraged) – solar freezers

Grant	NPV	Leveraged IRR
0%	-€ 3,272	1.1%
10%	-€ 2,615	2.7%
20%	-€ 1,958	4.3%
30%	-€ 1,301	6.1%
40%	-€ 644	8.0%
50%	€ 14	10.0%
60%	€ 671	12.2%
70%	€ 1,328	14.6%
80%	€ 1,985	17.1%
90%	€ 2,642	19.8%
100%	€ 3,299	22.8%

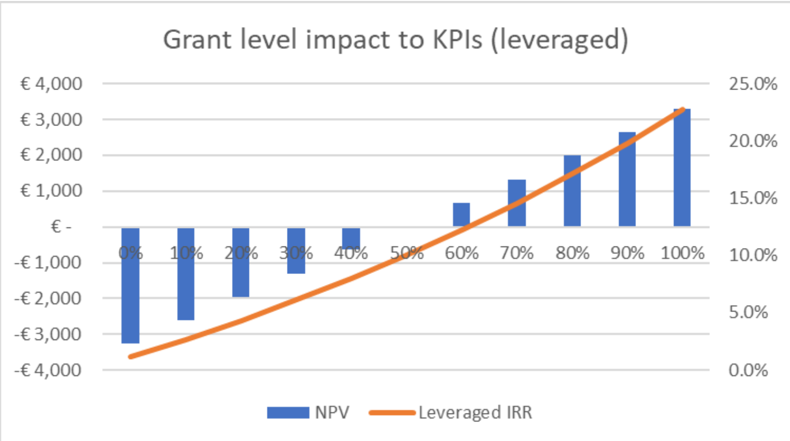

Figure 7 Grant level impact to KPIs (leveraged) – solar freezers

Table 43 Interest rate level impact to KPIs (No grant) – copra dryers

Interest rate	NPV	Leveraged IRR
1%	-€ 1,758	4.9%
2%	-€ 1,986	4.3%
3%	-€ 2,140	3.9%
4%	-€ 2,296	3.5%
5%	-€ 2,454	3.1%
6%	-€ 2,614	2.7%
7%	-€ 2,776	2.3%
8%	-€ 2,940	1.9%
9%	-€ 3,105	1.5%
10%	-€ 3,272	1.1%

11%	-€	3,441	0.7%
12%	-€	3,611	0.4%

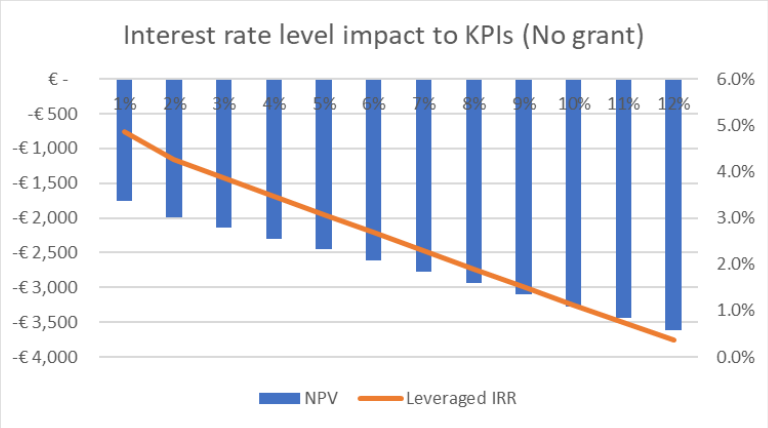

Figure 8 Interest rate level impact to KPIs (No grant included) – solar freezers

3.1. Findings

92. The results within both sensitivity analysis shows that grant financing is required for solar freezers. Grant of 50% or more would be needed in order to achieve profitability.

93. The financial analysis was undertaken in order to test the financial profitability of potentially revenue-generating activities that would be undertaken by the project. However, it should be considered that this is theoretical potential and does not take into account market readiness. Additionally, it is noteworthy that potentially revenue-generating activities accounts for only approx. 6% of the entire project budget.

94. Copra driers and yam production have the highest financial potential based on financial analysis results. Those are profitable under every scenario.

95. Taro production and solar freezers are profitable in case grant is applied. For solar freezers that is expected as those are usually not primary focus of a given business production but rather part of a value chain – in the case of this analysis, fish processing and storage.

96. Monthly loan instalment payments vs. monthly income should be considered with some reservation as the country average top-down value was used. Due to data limitations it was not possible to obtain disaggregated data that would precisely define income of different groups of farmers and processors. Additionally, considering subsistence nature of agricultural and food production in Vanuatu, it is highly unlikely that average monthly income includes revenues from types of activities considered under this project.

4. Conclusion

97. The report shows that **all four of the adaptation measures analysed have an economic internal rate of return significantly higher than the discount rate and can be justified on economic grounds.** The analysis shows that the selected measures will have a significantly positive economic impact for the targeted communities over the life of the project and beyond.

98. Financial analysis results in favourable profitability results for every potential revenue-generating activity. This clearly shows that the project has potential to be sustainable and trigger scale-up investments beyond its lifetime.

99. The support provided by the non-investment costs is appropriate to the context of Vanuatu as a Pacific SIDS and Least Developed Country, with significant institutional capacity gaps and constraints at all levels to develop and implement adaptation actions in the most vulnerable remote and rural communities. **These non-investment costs are a critical component of ensuring the project generates transformational change and creates a paradigm shift in resilience for the most vulnerable communities in Vanuatu.**

100. **The project represents an excellent value for money investment for the GCF**.