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Strengthening the resilience of ecosystems and populations in four regional hubs in northern Mauritania

Annex 3: Economic Feasibility Assessment

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1. Introduction

The purpose of this financial and economic assessment document is to:

- outline the approach and method adopted with respect to performing the financial analysis, quantifying the economic benefits and calculating the relevant financial and economic indicators;
- outline the limitations and primary assumptions of the analysis; and
- outline the data sources used in the analysis.

This financial and economic assessment report builds a robust investment case for GCF support by demonstrating the measurable value of ecosystem service improvements in the four target hubs in Mauritania. The financial and economic assessment report is set out as follows:

- Section 1 describes the purpose of the economic and financial analysis.
- Section 2 presents the financial and economic assessment approach.
- Section 3 describes the detailed methodological approach employed in the modelling process, and takes guidance from the GCF Guideline entitled “ANNEX VI Economic and Financial Analysis (EFA) Guidance”.
- Section 4 provides information on the implementation costs of the proposed project.
- Section 5 presents an analysis of the benefits of implementing the project.
- Section 6 provides the results of the financial and economic analysis (FEA) and the benefit-cost ratio of the project’s intervention.
- Section 7 describes the method used to check the assessments results against the main parameters of the analysis, including main drivers of the costs and revenues, as well as the discount rate.
- Section **Error! Reference source not found.** covers the motivation for grant finance.
- Section 9 details the conclusions arising from the FEA.

2. Financial and Economic Assessment Approach

This financial and economic assessment uses best-available data and tested methodologies to estimate baseline and post-intervention financial and economic values, focusing on key sectors critical to household resilience, namely crop and livestock production, water access, and overall health.

The assessment begins with the valuation of baseline ecosystem services using data from reliable national and international sources. This includes existing values for agricultural production, livestock yields, and water supply across the oasis-based systems in the intervention areas. These figures represent the starting point for estimating the incremental value added by the GCF project.

To assess the impact of GCF-financed interventions, an evidence-based ecosystem service indexing approach is employed. This approach quantifies the improvement in ecosystem service delivery, such as enhanced agricultural productivity, improved livestock health, and greater availability of water resources, following the implementation of project activities. These improved service values feed directly into the financial analysis model.

The financial analysis is conducted at the household level, with the understanding that households in the targeted hubs depend on a combination of crop cultivation and livestock management to sustain their livelihoods. Importantly, the analysis captures both subsistence use and surplus production that can be marketed or traded, providing a full picture of the financial potential of oasis-based agriculture. While much of the agricultural output in these systems is retained for household consumption, the financial analysis estimates potential returns based on prevailing local and regional prices. This approach allows the model to reflect both the immediate, tangible benefits to household food security



and the broader financial opportunities available through increased productivity and market engagement.

At the macroeconomic level, an integrated economic analysis is undertaken to assess the project's contribution to Mauritania's Gross Domestic Product (GDP). This analysis is holistic, capturing not only direct outputs from increased crop and livestock production but also the enhanced value of ecosystem services, such as water provisioning and the resulting improvements in health and productivity.

By comparing baseline conditions with projected post-intervention outcomes, the model clearly illustrates the financial and economic returns that can be expected through GCF support. These include gains in household income, improved food and water security, and measurable contributions to national GDP.

3. Detailed Methodology

3.1. Baseline ecosystem service valuation

The baseline valuation provides a monetary estimate of the key provisioning ecosystem services currently delivered by oasis-based systems in the four targeted hubs. These services include food production from crops and livestock, as well as access to water for domestic and productive use. Establishing a robust baseline is essential to understanding the current state of ecosystem service flows and to quantifying the added value of GCF-financed interventions.

Agricultural production in the targeted hubs is predominantly based on oasis systems, which combine date palm cultivation with rain-fed and flood-recession agriculture. These systems yield a mix of date crops, vegetables, and cereals. To estimate the value of crop production:

- Data from best-available research was used to approximate the area under rain-fed and flood-recession agriculture in each hub.
- Crop yield estimates, specific to the types of crops grown in these systems, were applied to the cultivated area to determine the total annual production volume.
- Similarly, data on date palm production volumes in each hub was gathered from existing agricultural records and studies.
- Market prices for dates, vegetables, and cereals, sourced from local and regional markets, were applied to the estimated volumes to calculate the annual monetary value of crop production per hub.

Livestock is a key component of household livelihoods in the project areas, contributing to both food security and income. To estimate the value of livestock production:

- Official data on livestock populations at the wilayah (regional) level was obtained.
- These figures were scaled down using the relative population share of each hub compared to its corresponding wilayah, to approximate livestock numbers at the hub level.
- Average meat yields per animal were sourced from relevant literature and applied to the estimated livestock populations to determine total annual meat production.
- Current market prices for meat in Mauritania were then used to derive the annual value of livestock production for each hub.

Access to water is another critical provisioning service, particularly in arid environments like those found in the target hubs. To estimate the value of water supply:

- Literature sources provided estimates of current per capita water use in the target areas.
- These figures were multiplied by the population of each hub to determine total annual water consumption, measured in litres.
- The cost of water, as reported in national and project-level studies, was then applied to calculate the annual monetary value of water accessed in each hub.



3.2. *Evidence-based ecosystem service indexing*

To quantify the projected benefits of GCF-financed interventions, an evidence-based indexing approach was developed to estimate the increase in ecosystem service values above the baseline. This indexing framework applies rigorously sourced multipliers to each key service, crop production, livestock production, and water supply, based on documented outcomes from comparable interventions in similar agroecological and socio-economic contexts.

The crop production index reflects the expected improvements in agricultural yield resulting from the adoption of climate-resilient agricultural practices. Drawing on findings from a World Bank study on climate-smart agriculture, which examined interventions comparable to those proposed in this project, it was found that crop yields increased by an average of 30% under improved land and water management techniques. This 30% uplift factor was used as the index for increased crop production across the project hubs following implementation of the GCF-supported activities.

For livestock, the index accounts for improved fodder availability and pasture productivity because of land rehabilitation efforts. Empirical research demonstrates that access to better grazing conditions can lead to significant weight gains in livestock, including camels, cattle, and small ruminants. Documented increases in live weight range from 11% to 48%, depending on species and conditions. For the purposes of this model, a conservative average uplift was applied to livestock productivity to estimate the post-intervention increase in meat yields and overall livestock value.

The water supply index is based on bridging the gap between current water access levels and actual daily water demand. According to available research, the average daily water demand in Mauritania is approximately 75 litres per person. However, current consumption in the project hubs is significantly lower, at around 38 litres per person per day. The project is expected to improve water access and infrastructure such that per capita water use approaches the national demand benchmark. The index therefore reflects this increase in per capita water access, nearly doubling the current level, as a proxy for the enhanced ecosystem service value of water provisioning.

3.3. *Financial analysis*

The financial analysis was developed to compare the current financial performance of oasis-based livelihoods with the projected improvements resulting from GCF project interventions. It includes two core components: a baseline scenario representing current economic conditions, and a project scenario that incorporates the benefits of improved ecosystem service delivery under the GCF-supported activities.

The baseline analysis captures the financial value generated at the household level from agricultural and livestock production, based on the ecosystem service valuation described earlier. Notably, the majority of this value accrues through subsistence consumption rather than through formal value chains or market-based transactions.

Due to the subsistence nature of these systems, reliable data on annual input costs and capital expenditures is limited. In response to this data constraint, the model draws on credible, research-backed estimates of typical financial returns from oasis-based agriculture systems in similar contexts. These research-derived Internal Rates of Return (IRRs) were applied as a benchmark.

To estimate costs, a goal-seek function was used: the model takes the known value of production (i.e., revenue potential) and solves for the cost input required to achieve the benchmark IRR. This allows for a consistent and evidence-based representation of the financial performance of the baseline scenario.

In the project scenario, the cash flow model integrates the increased production values obtained from the evidence-based ecosystem service indexing. These enhanced revenue projections reflect the expected gains from higher crop yields, improved livestock productivity, and better water access.



Using the same cost assumptions from the baseline model, the project scenario recalculates the IRR, effectively capturing the incremental financial return made possible through GCF support. This provides a clear, quantitative basis for understanding the value-add of the project from a household finance perspective, demonstrating how improved ecosystem productivity translates into stronger and more resilient rural livelihoods.

3.4. Economic analysis

The economic analysis captures the broader, economy-wide benefits of the project, including non-market ecosystem service gains and indirect multiplier effects.

The first component of the economic analysis involves estimating the additional Gross Domestic Product (GDP) generated as a result of increased ecosystem service productivity. Specifically, enhanced crop and livestock production and improved water availability. These outputs, previously quantified through the ecosystem service indexing approach, were monetized and aggregated to reflect their direct contribution to GDP.

To more accurately reflect the macroeconomic impact of improved agricultural performance, a multiplier effect was applied. Agriculture is a sector with high linkages to other parts of the economy. The application of a conservative, evidence-based multiplier accounts for the indirect economic activity generated by increased agricultural output in the project hubs.

In addition to market-based services, the analysis incorporates a critical non-market benefit: cost savings to the healthcare system. This benefit arises from reduced rates of malnutrition expected as a result of improved food and water security. A literature review indicates that treating malnourished individuals incurs significantly higher per capita healthcare costs than treating well-nourished patients.

Using available data, the current per capita healthcare cost in Mauritania was estimated, and the incremental cost of malnutrition treatment was factored in. This additional cost burden was then applied to the relevant segment of the population within the hubs. The economic analysis posits that improved livelihoods through GCF interventions will reduce the prevalence of malnutrition, leading to substantial future cost savings for the healthcare system.

All economic and ecosystem service benefits, market and non-market, were aggregated to estimate the total economic benefit of the project. Against this total, the full cost of the GCF-financed interventions was accounted for, allowing for the calculation of the project's net economic benefit.

4. Costs

The costs of the proposed project are based on the GCF funds per activity. Each output contains multiple activities. Note that the interventions will have capital costs and operating costs. Capital items will need to be maintained and replaced at predetermined time intervals (replacement period).



Table 1 shows the costs of the project interventions. The total cost for the interventions is US\$30,146,845. Table 2 shows the monitoring and evaluation costs. These costs amount to a total of US\$1,752,500. Table 3 shows the project management costs. These costs total US\$1,661,000. This brings the total cost of the GCF project to US\$33,560,345.

**Table 1.** Intervention costs.

Output	Activity	Sub-activity	Financing Source	Total cost (US\$)
Output 1.1. Governance structures are strengthened to support the implementation of EbA measures and the integration of climate change considerations and EbA into government plans, policies and budgets.	Activity 1.1.1. Establish coordination platforms to facilitate knowledge sharing, natural-resource management, sustainable land-use planning and the implementation of EbA activities at regional and local levels.	Sub-activity 1.1.1.1. Establish commune-level technical committees (CTCs) within each priority commune in the four target hubs.	GCF	3,000
			GCF	76,000
			GCF	11,124
			GCF	12,000
			GCF	960,000
			GCF	480,000
			GCF	3,000
		Sub-activity 1.1.1.2. Deliver training workshops to CTCs, enhancing members' capacities to implement and manage project activities, support the integration of climate change in regional- and commune-level policies, plans and budgets, and facilitate knowledge sharing between regional- and local-level stakeholders.	GCF	4,000
			GoM	9,600
			GCF	22,752
			GCF	25,728
			GCF	36,000
		Sub-activity 1.1.1.3. Train CTC members to use the existing National Adaptation Plan (NAP) climate knowledge management platform and facilitate the collection and dissemination of climate information and adaptation best practices by CTC members.	GCF	4,000
			GCF	6,000
			GCF	2,370
		Sub-activity 1.1.1.4. Conduct a review of existing wilayah-, moughataa- and commune-level development plans, policies and budgets and prepare policy briefs for the integration of climate considerations and gender-responsiveness into these documents.	GCF	24,000
			GCF	36,000



		Sub-activity 1.1.1.5. Convene training workshops for Regional and Communal Councils and relevant sectors to support the integration of climate change in regional- and commune-level policies, plans and budgets, including through the presentation of the policy briefs prepared under Sub-activity 1.1.1.4.	GCF	6,000
			GCF	12,000
			GCF	4,944
Subtotal GCF cost for Output 1.1				1,728,918
Subtotal GoM cost for Output 1.1				9,600
Subtotal Output 1.1				1,738,518
Output 1.2. Knowledge products developed and disseminated to support decision making and upscaling.	Activity 1.2.1. Develop knowledge products on project lessons learned and best practices through a participatory process engaging the communities.	Sub-activity 1.2.1.1. Hold bi-annual gender-inclusive discussions between representatives from the PMU, CTCs and communities in the target hubs on project intervention successes and challenges, and develop these discussions into community engagement reports.	GCF	51,456
			GCF	72,000
			GoM	9,600
			GCF	57,600
		Sub-activity 1.2.1.2. Identify lessons learned and best practices used in project interventions, and develop these into implementation guides and best practice reports.	GCF	38,400
	Activity 1.2.2. Enhance the dissemination of adaptation knowledge to sub-national decision-makers and communities to support upscaling.	Sub-activity 1.2.2.1. Upload knowledge products (e.g. implementation guides, monitoring and evaluation reports, community engagement reports, policy briefs, lessons learned and best practice reports) onto the NAP knowledge management platform.	GCF	12,000



		Sub-activity 1.2.2.2. Package knowledge in the NAP knowledge management platform into formats that are accessible at local level (e.g. brochures, TV and radio programmes, awareness-raising materials).	GCF	72,000
		Sub-activity 1.2.2.3. Disseminate locally-accessible knowledge products in target and non-target communes across the four project wilayahs to catalyze upscaling, with support from the DREDDs and CTCs.	GCF	90,000
			GoM	14,400
Subtotal GCF cost for Output 1.2				393,456
Subtotal GoM cost for Output 1.2				24,000
Subtotal Output 1.2				417,456
Output 2.1. Green-grey dune fixation infrastructure is established to control sand encroachment, enhance the provision of ecosystem services and slow the rate of desertification within the four target hubs.	Activity 2.1.1. Establish 2,123 hectares of EbA dune-fixation infrastructure and 120 kilometres of protective fencing across the four target hubs, to facilitate the rehabilitation and maintenance of degraded landscapes and enhance ecosystem services related to dune stabilisation and the supply of natural resources.	Sub-activity 2.1.1.1. Support CTCs to co-develop commune-level land rehabilitation plans in collaboration with village-level stakeholders, members of project management teams and DREDD representatives.	GCF	10,800
			GCF	9,888
			GCF	24,000
			GoM	270,000
		Sub-activity 2.1.1.2. Install ~2,123 ha of dune-stabilisation infrastructure (1,138 ha of green belts; 985 ha of biological and mechanical dune-fixation infrastructure) at strategic sites across the four target hubs — to protect critical areas against the impacts of sand inundation.	GCF	54,000
			GoM	7,200
			GCF	22,752
			GCF	2,129,064
			GoM	1,581,940
			GCF	720,000
			GCF	1,889,470
			GoM	188,030
		Sub-activity 2.1.1.3. Install ~120 km of fence lines around dune-fixation sites established under sub-activity 2.1.1.2, to protect biological dune-fixation infrastructure against damage from livestock and	GCF	2,881,293
			GCF	261,936
			GCF	0
			GCF	0



		unsustainable use of natural resources.		
		Sub-activity 2.1.1.4. Train livestock herders within the target communes to implement climate-resilient livestock management practices, such as rotational grazing, transhumance, supplementary feeding, agro-silvopasture, collective herding and 'livestock collar re-seeding'.	GCF	342,000
			GoM	72,000
			GCF	107,640
Subtotal GCF cost for Output 2.1			8,452,843	
Subtotal GoM cost for Output 2.1			2,119,170	
Subtotal Output 2.1			10,572,013	
Output 2.2. Improved access to water for agricultural and land rehabilitation activities.	Activity 2.2.1. Establish community-managed Water User Groups (WUGs) and commune-level water monitoring and regulation plans.	Sub-activity 2.2.1.1. Establish community-managed Water User Groups (WUGs) within each target commune and train members to implement and maintain water-related activities introduced under Activity 2.2.2 of the project.	GCF	16,000
			GCF	18,000
			GCF	4,944
			GCF	54,000
			GoM	32,800
			GCF	14,400
			GCF	19,296
		Sub-activity 2.2.1.2. Support CTCs to raise awareness about sustainable water usage and co-develop commune-level water monitoring and regulation plans in collaboration with WUGs.	GCF	420,000
			GCF	270,000
			GoM	100,000
		Sub-activity 2.2.1.3. Conduct hydrogeological studies (or consult existing hydrogeological maps, where applicable) and engage with WUG members to identify priority sites to install water-management infrastructure (Sub-activities 2.2.2.1, 2.2.2.2 and 2.2.3.1) in each target commune.	GCF	133,000
			GCF	18,000
			GCF	29,664



		Summarise the finding of site selection into a commune-level water management plan for each priority commune.		
	Activity 2.2.2. Install physical water management infrastructure — including weirs, gabions, dikes, stone- and earthen bunds, groundwater dams and water access points for pastoralists.	Sub-activity 2.2.2.1. Install physical water management infrastructure — including weirs, gabions, dikes, stone- and earthen bunds, groundwater dams and solar-powered pumps — at strategic sites within each target commune, to improve water access and availability, increase groundwater recharge rates and reduce flood risks in the target hubs.	GCF	1,481,200
			GCF	20,000
			GCF	160,000
			GCF	2,064,000
			GCF	288,000
			GCF	40,000
		Sub-activity 2.2.2.2. Establish water access points along historical transhumance routes and in graras, to improve nomadic pastoralists' access to water and reduce sedentarisation among livestock herders.	GCF	768,000
			GCF	110,400
			GCF	24,000
			GoM	20,000
	Activity 2.2.3. Install 12 rainwater-harvesting systems and communal cisterns (5,000 L per system) within each target commune	Sub-activity 2.2.3.1. Install 12 rainwater-harvesting systems and communal cisterns (5000L per system) within each target commune across the four hubs, to improve access to water for agricultural livelihood activities.	GCF	36,000
			GCF	480,240
			GCF	216,000
	Subtotal GCF cost for Output 2.2			
Subtotal GoM cost for Output 2.2				152,800
Subtotal Output 2.2				6,837,944
Output 2.3. Climate-resilient agricultural livelihoods based on sustainable land- and natural resource-use are developed and/or strengthened to	Activity 2.3.1. Facilitate the adoption of climate-smart agricultural practices and sustainable diversified livelihoods by	Sub-activity 2.3.1.1. Establish nurseries and seed banks in each target commune to supply activities related to land rehabilitation and dune fixation (Activity 2.1.1), CSA practices (Sub-activity 2.3.1.3) and	GCF	186,000
			GCF	72,000
			GCF	19,776
			GCF	438,000
			GCF	284,100



reduce land degradation and support climate-resilient income-generation by community members within the target regions.	farmers and community members within the target communes..	horticultural activities such as market-gardening (Sub-activity 2.3.1.4).	GCF	72,000
			GCF	19,776
			GCF	438,000
		Sub-activity 2.3.1.2. Collect cuttings and seeds from agricultural crop species, as well as indigenous grass and tree species, to serve as stock material for nurseries and seed banks established under Sub-activity 2.3.1.1.	GCF	18,000
			GCF	36,000
			GoM	3,600
		Sub-activity 2.3.1.3. Train farmers within the target communes to practice climate-resilient crop agriculture and use improved agricultural technologies, including drip irrigation kits, solar powered pumps, integrated pest management strategies, zai pits and half-moons.	GCF	270,000
			GoM	72,000
			GCF	96,480
			GCF	95,600
		Sub-activity 2.3.1.4. Conduct site visits and provide technical support to facilitate the uptake of sustainable livelihood activities — including horticulture (market-gardening), apiculture, poultry farming, livestock feed production and the collection and sale of non-timber forest products — by community members within the target communes.	GCF	162,000
			GoM	43,200
			GCF	44,496
		Sub-activity 2.3.1.5. Supply farmers and horticulturalists with water-efficient irrigation equipment and climate-resilient crop varieties to support the uptake of agricultural activities adopted under Sub-activities 2.3.1.3 and 2.3.1.4.	GCF	99,000
			GCF	10,350
			GCF	103,500



		Sub-activity 2.3.1.6. Improve access to urban markets and develop value chains for offloading agricultural produce within each target commune, to enhance income generated from sustainable agricultural livelihoods.	GCF	108,000
			GoM	23,200
			GCF	19,776
	Activity 2.3.2. Establish a small grants facility to facilitate continued investment in upscaling successful EbA activities and sustainable livelihoods.	Sub-activity 2.3.2.1. Establish and operationalise a Small Grants Facility (SGF) to facilitate continued investment in upscaling successful EbA activities and sustainable livelihoods introduced under the project.	GCF	24,000
			GCF	18,000
			GCF	960,000
			GCF	6,000,000
			GCF	20,000
			GCF	700,000
		Sub-activity 2.3.2.2. Prepare budget briefs for directing regional government funds into the SGF established under Sub-activity 2.3.2.1. to promote government investment in CCA.	GCF	18,000
			GCF	26,000
			GCF	2,060
			GCF	6,000
		Sub-activity 2.3.2.3. Develop monitoring and reporting mechanisms to ensure the traceability and risk management of funds between the SGF and local-level stakeholders.	GCF	36,000
			GCF	36,000
Subtotal GCF cost for Output 2.3				10,438,914
Subtotal GoM cost for Output 2.3				142,000
Subtotal Output 2.3				10,580,914

Table 2 Monitoring and evaluation costs

Monitoring and Evaluation Costs	Total cost (US\$)
Implementation of safeguards management plan	279,500
Environmental and Social Safeguards Officer	330,000
Implementation of gender mainstreaming	25,000
Gender Officer	330,000



Monitoring and Evaluation officer	330,000
Implementation of M&E plan	315,000
Terminal Evaluation	143,000
Total monitoring and evaluation costs	1,752,500

Table 3 Project management costs

Project Management Costs	Total cost (US\$)
Project Coordinator	450,000
Procurement Officer	110,000
Financial and Administrative Officer	330,000
Chief Technical Advisor	390,000
Facilities and administration	180,000
Office supplies and stationary	30,000
IT equipment	39,000
Audits	30,000
PMU travel costs	60,000
Project meeting costs	42,000
Total project management costs	1,661,000

5. Benefits

As previously mentioned in section 3.4 above, the economic benefits consider additions to GDP, a multiplier effect due to the economy-wide impact of agriculture and then the health benefit. Table 4 shows the value of each respective economic benefit (discounted @2% over a 20-year period. See section 3.4 for each of the target hubs. The total value (NPV) of the additional GDP created as a result of increased ecosystem services from GCF project interventions is US\$128 million over the 20-year modelled period. The multiplier effect of agriculture further adds US\$29 million (NPV) to the GDP impact. The value (NPV) of the health benefit is US\$24 million, bringing the total value (NPV) of the economic and ecosystem service benefits to US\$182 million over the 20-year modelled period.

Table 4 Economic and ecosystem service benefits

Indicator	Unit	Total/Combined	Aoujeft	Rachid	Tamcheket	Nema
NPV of Additional GDP Created: Crop production	\$	59,481,666	15,109,319	11,970,674	6,548,349	25,853,324
NPV of Additional GDP Created: Livestock production	\$	68,062,303	2,608,242	26,018,603	14,118,407	25,317,050
NPV of Additional GDP Created: Water supply	\$	872,455	52,286	197,184	165,542	457,444
NPV of Multiplier effect	\$	29,933,811	4,142,143	8,901,247	4,855,999	12,034,421
NPV of Health Benefit	\$	24,337,247	1,458,515	5,500,464	4,617,809	12,760,459
NPV of Total Economic & Ecosystem Service Benefit	\$	182,687,481	23,370,505	52,588,172	30,306,107	76,422,699

6. FEA Results

Table 5 presents a comprehensive comparison of baseline and project scenarios across the four target hubs in Mauritania, along with aggregated totals. The analysis confirms that GCF support significantly enhances both the financial viability and economic impact of oasis-based livelihoods.



Crop production revenue potential increases by over US\$5.1 million annually in real terms, rising from \$17.0 million to \$22.1 million totalled across all hubs. Notably, hubs like Aoujeft see large gains most likely due to its location in the major date producing region. Livestock production revenue potential shows a substantial gain of \$5.8 million per annum, increasing from \$53.2 million to \$59.0 million. The water supply revenue potential also more than doubles (from \$76,992 to \$151,959), reinforcing the significance of improved water access in climate-vulnerable zones.

The NPV of total economic and ecosystem service benefits is calculated at over \$182 million, vastly exceeding the NPV of the project costs of \$31.2 million. This translates into a benefit-to-cost ratio of 5.86, meaning that for every \$1 invested by GCF, nearly \$6 is generated in the economy in return.

The projected health benefit NPV of \$24.3 million accounts for future cost savings in treating patients who were malnourished, a powerful, non-market benefit that aligns with SDG 3 (Good Health and Well-Being).

Financial IRR increases from 12% to 22% with GCF support, indicating a notable improvement in the potential for household-level returns from agricultural production. The Economic Rate of Return (ERR) is estimated at 29%, reflecting good economic impact.

It is once again worth noting that much of the value generated accrues to households through local consumption instead of through formal value chains and trade, which would generate the sufficient cashflows needed to sustain alternative funding instruments. This supports the use of grant funding in this project. The GCF-funded intervention will likely enable conditions that can foster the development of nascent markets, contributing to financial sustainability of the intervention in the future beyond the GCF funding cycle. Further to the above, while scaling of the project within existing project sites is not very likely due to the spatial arrangement of oasis-based agricultural systems, the project is replicable in similar socio-economic, climatic and ecological conditions.

Table 5 Results of financial and economic assessment

Indicator	Unit	Total/Combined	Aoujeft	Rachid	Tamcheket	Nema
Baseline scenario (without GCF support)						
Revenue potential: Crop production - Real terms	\$/annum	17,036,661	4,327,591	3,428,625	1,875,570	7,404,875
Revenue potential: Livestock production - Real terms	\$/annum	53,166,317	2,037,407	20,324,221	11,028,480	19,776,209
Revenue potential: Water supply - Real terms	\$/annum	76,992	4,614	17,401	14,609	40,368
Financial IRR	%	12%				
Project scenario (with GCF support)						
Revenue potential: Crop production - Real terms	\$/annum	22,147,660	5,625,869	4,457,212	2,438,241	9,626,338
Revenue potential: Livestock production - Real terms	\$/annum	59,014,612	2,261,522	22,559,885	12,241,613	21,951,592
Revenue potential: Water supply - Real terms	\$/annum	151,959	9,107	34,344	28,833	79,675
NPV of Additional GDP Created: Crop production	\$	59,481,666	15,109,319	11,970,674	6,548,349	25,853,324
NPV of Additional GDP Created: Livestock production	\$	68,062,303	2,608,242	26,018,603	14,118,407	25,317,050
NPV of Additional GDP Created: Water supply	\$	872,455	52,286	197,184	165,542	457,444
NPV of Multiplier effect	\$	29,933,811	4,142,143	8,901,247	4,855,999	12,034,421
NPV of Health Benefit	\$	24,337,247	1,458,515	5,500,464	4,617,809	12,760,459



NPV of Total Economic & Ecosystem Service Benefit	\$	182,687,481	23,370,505	52,588,172	30,306,107	76,422,699
NPV of Project Costs	\$	31,161,479				
Financial IRR	%	22%				
ERR	%	29%				
Benefit-to-cost Ratio	%	5.86				

7. Sensitivity analysis

Given the significant assumptions made in the CBA modelling, it is prudent to assess a range of variables on the modelling outcomes. The key variables that were assessed for variation are identified as:

- Change in date production;
- Change in average meat yield from all livestock;
- Change in health cost per capita;
- Change in social discount rate; and
- Change in commercial (money) discount rate.

The way the FEA model is set up for sensitivity analysis is that one can select one of the above scenarios and specify the percentage by which a variable can be changed. The model then runs and results are updated. One can then make a comparison of the original or most-likely results to the new results based on the changes specified. The parameters specified are as follows:



Scenario definition			
#	Scenario	Description	Specify amount (indicate +/- with value) N/A
0	Most likely scenario		
1	Change in date production	Specify a percentage increase/decrease of date production in each of the hubs	1%
2	Change in average meat yield from all livestock	Specify a percentage increase/decrease of the average meat yield from all livestock	1%
3	Change in health cost per capita	Specify a percentage increase/decrease of the health cost per capita	1%
4	Change in social discount rate	Specify a percentage increase/decrease of the social discount rate used in the economic analysis	1%
5	Change in commercial (money) discount rate	Specify a percentage increase/decrease of the money discount rate used in the financial analysis	1%

The above variables were tested independently and their respective impacts on costs, benefits and the cost-benefit ratio were calculated.

The outcomes of the sensitivity analysis are outlined in Figure 1 below:

Sensitivity Results								
	Hub	Unit						
Scenario indicator			Most likely scenario	Change in date production	Change in average meat yield from all livestock	Change in health cost per capita	Change in social discount rate	Change in commercial (money) discount rate
Revenue potential of agriculture activities (after project interventions)	Aoujeft	\$/annum	7,896,497	7,952,756	7,919,113	7,896,497	7,896,497	7,896,497
	Rachid	\$/annum	27,051,442	27,091,311	27,277,041	27,051,442	27,051,442	27,051,442
	Tamcheket	\$/annum	14,708,686	14,725,017	14,831,102	14,708,686	14,708,686	14,708,686
	Nema	\$/annum	31,657,605	31,686,478	31,877,121	31,657,605	31,657,605	31,657,605
Financial return: IRR with GCF support	Combined	%	21.85%	21.94%	22.24%	21.85%	21.85%	21.85%
NPV of net cashflows with GCF support	Combined	\$	42,639,899	43,194,526	44,929,040	42,648,322	42,648,322	35,866,308
NPV of economic and eco-system service benefits	Combined	\$	182,687,481	184,715,719	191,156,539	182,930,854	161,133,224	182,687,481
Economic rate of return: ERR with GCF support	Combined	%	28.76%	28.99%	29.71%	28.78%	28.76%	28.76%
% Change From Most Likely Scenario								
indicator								
Revenue potential of agriculture activities (after project interventions)	Aoujeft		0.0%	0.7%	0.3%	0.0%	0.0%	0.0%
	Rachid		0.0%	0.1%	0.8%	0.0%	0.0%	0.0%
	Tamcheket		0.0%	0.1%	0.8%	0.0%	0.0%	0.0%
	Nema		0.0%	0.1%	0.7%	0.0%	0.0%	0.0%
Financial return: IRR with GCF support	Combined		0.0%	0.4%	1.8%	0.0%	0.0%	0.0%
NPV of net cashflows with GCF support	Combined		0.0%	1.3%	5.4%	0.0%	0.0%	-15.9%
NPV of economic and eco-system service benefits	Combined		0.0%	1.1%	4.6%	0.1%	-11.8%	0.0%
Economic rate of return: ERR with GCF support	Combined		0.0%	0.8%	3.3%	0.1%	0.0%	0.0%

Figure 1 Sensitivity analysis results (see Sensitivity Analysis tab in Annex 3)

The sensitivity analysis shows how a 1% increase in the variables analysed impacts the results. For example, a 1% increase in date production in each of the hubs causes the NPV of economic and eco-system service benefits to increase by 1.1%.



8. Motivation for Grant Finance

Although the proposed project supports climate-smart agricultural and livelihood practices, with the potential for increased income and profit generation accrual at the community level, several factors justify the request for 100% grant finance. These factors are listed below.

- **Multidimensional poverty and structural impediments:** Mauritania's substantial interdimensional poverty and structural impediments to sustainable development significantly limit local communities' upfront investment capacity in climate-smart solutions. Despite the potential for long-term economic benefits, the initial financial barrier and the time required to realise returns on investment pose significant challenges for communities already living at the margin. This suggests that proposed project interventions are unlikely to result in surplus income for beneficiaries. Instead, introduced income-generating activities will focus on bringing local GDP, food production and water access up to acceptable minimum standards — thereby providing communal economic benefits rather than individual financial benefits.
- **Fiscal constraints and national prioritisation:** The GoM's high public debt level and fiscal constraints limit the allocation of national resources towards climate change adaptation. National priorities generally focus on immediate development needs; therefore, limited budgetary leeway reduces scope for investing in long-term climate resilience initiatives without external support.
- **Private sector participation:** As described above, the proposed project operates in areas with minimal private sector presence, further compounded by limited potential for immediate cost-recovery and revenue generation due to the nature of EbA interventions. This scenario limits the attraction of private investment in the short to medium term, necessitating grant support to initiate and demonstrate the viability of such interventions.
- **Leveraging grant finance for systemic change:** Grant financing from the GCF is sought not only as a funding mechanism, but as a catalyst for systemic change. By providing 100% grant finance, the GCF will enable the implementation of foundational EbA measures that lay the groundwork for sustainable, climate-resilient development. The grant support will facilitate the establishment of necessary infrastructure, capacity building and institutional frameworks, setting the stage for future investments and scaling.
- **Demonstration effect and scalability:** The successful implementation of the project with GCF grant finance will serve as a demonstration of the viability and effectiveness of EbA measures, potentially attracting future investments from both public and private sectors. By proving the concept and showcasing tangible benefits, the project will create a replicable model for climate resilience that can be scaled both within Mauritania and in other similar contexts. This highlights the scalability of the project in terms of replicability, with low potential for *in situ* scaling at original project sites due to the spatial arrangements of oasis-based agriculture.

8.1. General analysis

The project interventions are designed to enhance community resilience and sustainable development in the face of climate change, focusing on long-term benefits rather than immediate financial gain. Given the communal nature of the benefits, such as increased resilience to climate impacts, improved ecosystem services and stronger institutional capacities, the financial returns are social and environmental, not monetarily direct or individual.

On the basis of this high-level financial analysis, 100% grant financing from the GCF is justified for this project, since the activities:

- require significant upfront investment without direct financial return or a secure revenue base;
- deliver communal and environmental benefits that are crucial for long-term resilience and sustainability; and



- support adaptive capacity and livelihood security improvements that are not quantifiable in immediate financial terms.

This analysis demonstrates that grant finance is the most appropriate instrument for the proposed project, considering the communal benefits, the non-revenue-generating nature of the activities and the critical need for adaptation and resilience-building in Mauritania.

9. Conclusion

In conclusion, the financial and economic assessment strongly supports the viability and impact of the proposed project interventions in northern Mauritania. The cost-benefit analysis reveals that, even under conservative scenarios, the project delivers a positive return on investment with benefit-to-cost ratio of 5.86. These findings underscore the effectiveness of ecosystem-based adaptation (EbA) in strengthening household and community resilience to climate change through improved agricultural productivity, water access, and ecosystem health. Notably, even in the least favourable sensitivity scenario, the interventions remain cost-effective, which provides confidence in the robustness of the proposed measures.

Despite the promising returns, the analysis clearly demonstrates the need for 100% grant financing. Given the communal nature of the benefits, the absence of surplus income for direct beneficiaries, and the high upfront costs of foundational infrastructure and capacity-building activities, the project is not suitable for loan-based or cost-recovery financing. The project is aimed at lifting communities above subsistence thresholds, not generating profit. As such, GCF funding serves as a catalyst for transformative change, enabling systemic shifts in climate resilience, institutional capacity, and long-term development. Ensuring successful implementation will depend on continued technical support, strong governance structures, and active community participation to realize the full potential of the interventions.