



Intensification of Agriculture and Agroforestry Technologies (IAAT) for Climate Resilient Food and Nutrition Security: Tombouctou, Gao, Mopti, Koulikoro and Segou Regions of Mali

Annex 21: Operations and Maintenance Plan

Accredited Entity: Save the Children Australia

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1 Scope for Operation and Maintenance Activities

1. The Operation and Maintenance (O&M) Plan for the Intensification of Agriculture and Agroforestry Technologies (IAAT) proposed GCF-funded project in Mali focuses specifically on equipment procured for activities in four project components. The IAAT project will support climate-vulnerable smallholder agricultural production systems and rural livelihoods in Mali to increase climate resilience and low-emission development pathways. The project has four components: 1) increase adoption of improved and climate-smart agroforestry and agricultural technologies, practices, and services, 2) increase connectivity of smallholders, women, and youth to the agriculture input and output markets, 3) reduce GHG emissions through the promotion of agroforestry, use of solar pump irrigation, and manure management through biogas plants, 4) strengthen institutional and stakeholders' capacities for scaling-up improved and climate-smart agroforestry and agriculture.
2. The IAAT project will work to help build community and market system resilience via a range of actions at local, regional, and national levels to increase knowledge and awareness of climate-smart agriculture (CSA), build the skills necessary to ensure agriculture and natural resource-dependent communities have the adaptive capacity to manage unavoidable impacts and make their own informed adaptation decisions at farm and community levels.

The project activities that include equipment purchased requiring an O&M plan are:

Component	Project activities	O&M plan Requirement
Component 1: Extension services and on-farm CSA adoption		
Output 1.1: Improved technical capacities and inclusivity of extension services in climate-smart agriculture and agroforestry production	Activity 1.1.1: Build technical capacity and reach of extension services on CSA and agroforestry techniques.	NO
Output 1.2: Increased use of climate-resilient practices in the production of CSA crops, livestock, and agroforestry by smallholder farmers	Activity 1.2.1: Build awareness, capacity, community interest, and field-level adoption of CSA techniques and agroforestry amongst smallholder farmer communities (crop and/or livestock)	NO
Component 2: CSA and Agroforestry Technologies		
Output 2.1: CSA and agroforestry VCs are more connected and reach more smallholder farmers.	Activity 2.1.1: Support the creation of inclusive private sector value chains for key CSA/agroforestry crops and technologies.	NO
Output 2.2: Smallholder farmers, especially youth and women, can more easily overcome barriers to entrepreneurship in CSA and agribusiness.	Activity 2.2.1 Support local financial institutions to increase access to finance for smallholder farmers, especially women, and youth for CSA/agroforestry investments.	NO
	Activity 2.2.2 Enhance capabilities and connectivity of youth and women CSA/agribusiness entrepreneurs.	NO

Component 3: Mitigation and Adaptation Technologies		
Output 3.1: Increased adoption of climate-smart agriculture technologies by smallholder farmers	Activity 3.1.1 Install and support the productive use of biodigester and solar irrigation systems among smallholder farmers.	YES
Output 3.2: Increased land area under agroforestry	Activity 3.2.1 Develop land-use mapping at the regional level.	
	Activity 3.2.2 Plant agroforestry trees on community and state-owned lands	NO
Component 4: Institutional Capacity and Knowledge		
Output 4.1: Increased institutional capacity in climate change adaptation and mitigation planning and best practices to address agriculture-related climate risks.	Activity 4.1.1 Strengthen institutional capacity in localized climate change adaptation and mitigation planning.	NO
	Activity 4.1.2 Technical capacity building of national climate funding institutions for disbursements management	NO
Output 4.2: Enhanced knowledge sharing and coordination of best practices in CSA and agroforestry across stakeholders.	Activity 4.2.1 Enhanced convening and contribution to national databases for CSA and Agroforestry	NO

2 Management System for Undertaking O&M Activities

The O&M plan has been developed with the community-based approach of the project, ensuring ownership and the mainstreaming of climate-smart agricultural technologies and practices within the farm and local community. Accordingly, O&M for the project will be carried out through a locally led approach with support from the Mali Government.

During the procurement process, O&M will be addressed by exploring extended warranties and including O&M as part of the procurement specifications for individual project inputs. The ongoing management of O&M will be tailored to each specific location in consultation with the local government and communities and included in the adaptation plans (Component 4 activity 4.1.1) and planning for the handover of project equipment to the project beneficiaries for long-term sustainability.

2.1 Main Stakeholders and Responsible Parties

The following stakeholders shall play a significant role in ensuring the effective implementation and sustainability of climate-resilient O&M practices. Stakeholder engagement is a key part of IAAT activity development and implementation process, including effective operation and management.

The O&M plan for the project is centered around the following key stakeholders:

1. Regional and Local (circle level) authorities: have established networks in communities, can influence management interventions, and benefit from development activities in their areas. At the local level, the agricultural office manager (AOM) and the Local Committee of Coordination (LCC) work with the local livestock, forestry, and farmer organization officers to ensure effective extension delivery.

2. Farmers Groups and Organizations: field agents and farmers' groups are key elements of technology transfer and adoption at the village level. Each village is mandated to have the Economic, Social, and Cultural Development Plan (PDESC in French) including assessing risks and vulnerabilities and climate change adaptation activities.
3. Community Beneficiaries: have been identified as extremely vulnerable to climate variability and extremes, which is impacting their food security and demonstrating a deficit in adaptive capacity. Remote communities receive limited training and support.
4. Private Sector: provides CSA technologies and inputs and local communities to output markets. The private sector will help to validate relevant national and local skills and capacity-building mechanisms and provide access to youth-focused private sector partnerships.
5. Suppliers: will be accountable for O&M as per the contracts (including extended warranties) on the goods that are purchased from them.

2.2 Roles and Responsibilities of the Stakeholders and Responsible Parties

1. Farmers' Groups and Organizations: will receive solar irrigation systems and biodigesters as a part of CSA activities to be implemented by individual farms or groups of farmers. The rules and regulations for the use, management, and O&M of solar irrigation and biodigesters will be proposed, adopted, and enforced by the members themselves, through majority agreement and ensuring gender equality and inclusiveness. The farmers' groups and organizations will also be responsible for ongoing monitoring of the communities' O&M of project equipment including solar irrigation systems, biodigesters, and other tools and equipment required to implement CSA activities at the farm and community levels. Project activities will include training on the use and maintenance of CSA equipment. Procurement of the equipment will consider maintenance schedules with suppliers and extended warranties to support long-term O&M after the project.
2. Community beneficiaries: These will include all communities benefitting from CSA and agroforestry interventions at the farm and community levels. They will significantly contribute to the implementation of CSA and agroforestry interventions that are suited to their local environmental and socioeconomic conditions through participatory methods to ensure that all proposed activities are entered into voluntarily and with broad community support. Regional, circle, and village authorities/committees, local NGOs, and CSOs will support communities to ensure high-quality maintenance and management of project-related improvements.
3. Private sector and suppliers: will support operation and maintenance training and capacity building for the use of solar irrigation systems and biodigesters as a part of the project activity (3.1).

2.3 Other project activities focused on establishing the long-term O&M framework.

During the five-year implementation period, the activities undertaken will aim to establish a long-term, 'beyond the life of project' O&M framework, including the development of Standard Operating Procedures (SOPs) for O&M on all durable goods, setting-up of systems, and building the capacity of stakeholders as well as communities for ensuring the sustainability of climate-resilient O&M practices.

The approach chosen and used will be discussed and agreed upon with Regional and local (circle level) authorities, Farmers' Groups and Organizations, AEDD, regional and local agriculture authorities, and relevant technical line ministries to ensure the approach is consultative and participatory, as well as technically robust and reflects the needs and desires of the end-users – farming households and communities. The government extension workers will be trained to provide technical expertise to help communities with development, facilitation, and assistance in designing, costing, and ensuring the establishment of appropriate O&M systems. Communities will be trained in planning and implementation of effective O&M of equipment, and community groups will build their organizational capacities to program and manage equipment, monitor usage, and develop O&M mechanisms for any community-held or shared equipment, including capitalization strategies.

2.4 Technical Support During the Project for Setting up the O&M Framework

During the project period, technical specialists supported by both suppliers providing equipment and the project's PMU will assist lead farmers and communities in establishing and operationalizing O&M management plans. These teams will establish the basic roles and responsibilities of those managing project equipment, as well as formulate specific SOPs, where appropriate, to ensure effective implementation of O&M plans. The shared resources include:

- Large solar pumping systems and biodigesters
- Water sources and rainwater harvesting structures.
- Rainwater tanks, agricultural tools, and fencing materials management and maintenance responsibilities to beneficiary households/communities
- Agroforestry plantation areas in the communal lands

3 Maintenance of Solar Pumping Systems

IAAT will promote multipurpose solar water pumping systems for agriculture (crop and livestock production) and domestic uses.

3.1 Maintenance tasks

Key tasks for the multipurpose solar water pumping systems include:

- Manually cleaning of solar panels
- Regular inspection of solar panel connections (looking for loose connections and hot spots), pump controller, and motor pump
- Repair or replacement of solar panel and pump
- Regular security checks and maintenance of solar pumping site

3.2 O&M Schedule

O&M schedules will be developed by private solar company during project initiation. Table 1 provides an estimate of the types and frequency of tasks that will be included to ensure proper O&M of solar pumping system during the project period.

Table 1: O&M schedule detailing tasks and frequency for activities to be undertaken

Task	Responsible Party	Description/Details	Frequency	Estimated Cost	Estimated cost - Post Project
Installation of solar panels and pumping system	SCI Mali	Installation of solar panels and pump system (connection with solar power source, transmission line, water supply system, etc.)	One-time by suppliers	Average \$ 8,000 for a set of solar panels and a pump	One time investment during the project period. No post-project cost
Regular scheduled maintenance	Solar pump irrigation system users	Inspection of solar panels and pump systems in accordance with manufacturers' guidelines.	Annual	\$16/ solar irrigation system	\$16/ solar irrigation system/year in the post-project period
Manually cleaning of solar panels	Solar pump irrigation system users	Removing dust for maximum solar exposure on the panel	3 times a year	\$20/ solar irrigation system	\$20/ solar irrigation system/year in the post-project period
Repair or replacement of panel and pump	Solar pump irrigation system users	For damaged or faulty equipment, during annual inspection or immediately when detected at other times.	As required	Solar pump irrigation system will have 15 warranties, no additional cost is required	The warranties cover 10 years post-project period
Security and maintenance of site	Solar pump irrigation system users	Appointed community member to provide security and maintenance of site	Weekly	This will be done by households or communities during the project period	This will be done by households or communities in the post-project period

Note: Table 1 provides per unit O&M cost and total lifetime cost for the solar system. The total estimated cost during the project period and the total estimated costs post-project are presented in Table 5 below.

3.3 Funding of O&M activities for solar pumping systems

A total of USD 900 is expected to be incurred for O&M of the solar pumping systems during the project period. Within the 15-year post-project period O&M is expected to be USD 368,100 that will be incurred by the communities. During the procurement process for the solar pumping system, options for extended warranty and service agreements will be explored with the suppliers to finance O&M and replacement part costs during the project period.

4 Maintenance of biodigesters

IAAT will promote small and medium-sized biodigester systems for domestic uses. Technical specialists from the project will assist basic O&M of biodigester.

4.1 Maintenance tasks

Key tasks for the biodigester systems include:

- Regular inspection of the biodigester system (looking for loose connections gas pipes, stoves, and hot spots)
- Regular feeding to operate the biodigester system.
- Repair or cleaning of biodigester tank
- Regular maintenance of biodigester

4.2 O&M Schedule

Table 2: O&M schedule detailing tasks and frequency for activities to be undertaken.

Task	Responsible Party	Description/Details	Frequency	Estimated Cost	Estimated cost - Post Project
Construction of biodigester system	SCI Mali	Construction of anaerobic digester, feed stock mixing tank, and slurry pit, Installation of gas piping system and biogas stove	One-time by suppliers	Average \$ 650 for a biodigester	One-time investment during the project period. No post-project cost
Regular feeding to operate the biodigester system	Biodigester users	Use an adequate quantity (based on the size of the biodigester tank) of dung daily through proper mixing with water and/or urine.	Daily	The biodigester owner will perform this task daily	The biodigester owner will continue this task daily in the post-project period
Regularly scheduled maintenance	Biodigester users	Inspection of biodigester system including digester, gas piping, and gas stove in accordance with manufacturers' guidelines.	Annual	\$10 per biodigester per year	\$10 per biodigester per year in the post-project period
Repair or replacement of damaged components	Biodigester users	For damaged or faulty equipment, during annual inspection or immediately when detected at other times.	As required	\$22.5 per biodigester per year	\$22.5 per biodigester per year in the post-project period

per unit O&M cost and total lifetime cost for the biodigester system. The total estimated cost during the project period and the total estimated cost of the project are presented in Table 5 below.

4.3 Funding of O&M activities for satellite and solar PV systems

A total of USD 90,250 is expected to be incurred for O&M of the solar pumping systems during the project period. Within the 15-year post-project period O&M is expected to be USD 2,074,350 that will be incurred by the communities. During the procurement process for the biodigester system, options for extended warranty and service agreements will be explored with the suppliers to finance O&M and replacement part costs during the project period. Regular O&M and replacement costs outside of the warranty and service agreement will be managed by individual or community biodigester users. Technical support will be provided by the project in collaboration with private biodigester suppliers.

5 Design Lifespan and replacement assumptions for equipment.

The following tables (Table 3 and Table 4) provide details on the expected lifespan of equipment for the project and estimated major replacement expenses that are expected to be incurred post-project implementation up to the year 2038.

Table 3: Assumption for the replacement frequency of equipment

Equipment type	Expected useful life
Solar PV system	15-20 years
Biodigester	20 years

Table 4 below details the replacement cycles for various equipment, the timing of when replacement costs are likely to be incurred and the assumption for financing of such costs.

Table 4: Description of Major Repairs/Replacements

Replacements	Timing	Financing assumption
Solar panel	Within the 15-year post-project period	Costs would be incurred by the community or provided by the government or supported by other development projects.
Biodigester	Within the 15-year post-project period	Costs would be incurred by the community or provided by the government or supported by other development projects.

6 Financial Summary

The estimated O&M plan costs have been proposed for a period of 15 years, which includes the 5-year project implementation period (2025-2029) and 10 years after project completion (2029-2038) for practical considerations. O&M activities are expected to be undertaken both during project implementation and post-project completion.

During the implementation period, O&M expenses will be incurred for equipment procured for activities 3.1.1. Post-project activities, which include regular O&M and major repairs/replacements, are expected to be carried out by the respective stakeholders regularly or as per the planned schedule. Post-project replacement costs are expected to be incurred based on the lifespans of the equipment.

Financing for the O&M plan during project implementation will be determined through the procurement process, exploring extended warranties, and service agreements and including O&M as part of the procurement for individual project inputs. GCF financing will be employed for the effective implementation of climate-resilient O&M practices. The ongoing cost of O&M will be included in the community adoption plans so they are tailored to each specific location.

Co-financing and post-project commitment: The EEs and line ministries have agreed to establish robust and sustainable O&M plans in consultation with the regional and local committees, ensuring the needs of the end users. The relevant line ministries have committed to including, if needed, an ongoing ministry budget to support recurrent costs.

Community financing: Community contributions will be in the form of cash (i.e. recurring costs for minor repairs, regular maintenance, and sharing of replacement costs) as well as in-kind (i.e. labor costs for undertaking monitoring and repairs, installation and replacement, peer-to-peer cooperative support). Community financing will be mobilized through the farmers' group and their local organizations that will drive the implementation and monitoring of the O&M activities. **Table 5** below shows the year-wise forecasts for the annual O&M costs associated with the IAAT activities.

Table 5: Cost estimation of O&M (USD)

Activity No	Description	Funding Source	Project period (5 years)					Post-project period (10 years)										Project Period Total	Post project Total	Project Duration Total
			2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	(2025-2029)	(2030-2039)	(2025-2039)
3.1.1	Regular O&M activities including minor repair works or replacement parts – solar pumping systems	GCF																		
		Community Beneficiary		900	1,800	2,700	3,600	3,780	3,969	4,167	4,376	4,595	4,825	5,065	5,319	5,585	5,864	9,000	47,544	56,544
3.1.1	Regular O&M activities including minor repair works or replacement – biodigester system	GCF																		
		Community Beneficiary		8,125	16,250	24,375	32,500	34,125	35,831	37,622	39,503	41,479	43,553	45,730	48,017	50,418	52,939	81,250	429,220	510,470
	Total for O&M (USD)			9,025	18,050	27,075	36,100	37,905	39,800	41,790	43,879	46,073	48,377	50,796	53,336	56,002	58,803	90,250	476,765	567,015

Note:

1. Solar pump system O&M: For solar pump 5% of the capital cost over a lifetime, and for solar panel 4% of the capital cost over the lifetime. The total capital cost of the solar pump irrigation system (USD 8,000/unit). Biodigester O&M: 5% of the capital cost/year. Average total capital cost of a biodigester (USD 650/unit). USD 36 per year is the annualized O&M cost per solar pump irrigation system.
2. The annual total cost of O&M is estimated based on the number of solar pump irrigation and biodigester systems installed from the GCF funding. Installation of solar pump irrigation systems will start from the second year (2026) and the project will install 25 solar pump irrigation systems and continue the installation of additional 25 solar pump irrigation systems every year until 5th year. The O&M cost will increase every year based on the number of solar pump irrigation systems installed.
3. The project will start to install biodigester systems in the second year (2026) starting from 250 units, then continue the installation of additional 250 biodigester every year until 5th year. The O&M cost will increase every year based on the number of biodigester systems installed. The owner needs to feed biodigester from cattle dung and water and fee for annual biodigester system monitoring for the expert.
4. Total O&M costs during the post-project period (2030-2039) are estimated using 5% rate of annual O&M cost increments for both solar and biodigester.
5. O&M cost for solar pump irrigation systems and biodigester is low compared to the total investment. The owner only needs to clean solar panels, feed cattle dung and water into the biodigester, and pay a small fee for an annual solar pump irrigation system and biodigester monitoring for the expert. All beneficiaries (individual households or community/group) will cover this O&M cost for both solar pump irrigation and biodigester systems.