Upscaling Lowland Rice Production to Improve Food Security Through Improved Solar Powered Irrigation Practices

Closure Report for CTCN Technical Assistance

1. Basic information

Title of response plan	Upscaling Lowland Rice Production to improve food security through improved solar powered irrigation practices
Technical assistance reference number	AFCIA 2021000017
Country / countries	Liberia
NDE organisation	Environmental Protection Agency of Liberia
NDE focal point	Mr. Christopher B. Kabah TNA National Coordinator Environmental Protection Agency of Liberia kabahchristopher@gmail.com
NDE contact information	ckabah@epa.gov.lr
Proponent focal point and organisation	Mr Halala Willie Kokulo Ministry of Agriculture hkokulo@moa.gov.lr kokulohalala@gmail.com
Designer of the response plan	CTCN
Implementer(s) of technical assistance	CARES Limited in association with INTEGRATION environment & energy GmbH
Beneficiaries	Government of Liberia, EPAL and Ministry of Agriculture Smallholder farmers at pilot scheme
Sector(s) addressed	Renewable Energy Agriculture
Technologies supported	Solar Powered Irrigation Systems (SPIS) i.e., solar energy driven pumps with water efficient irrigation and rice cultivation systems.
Implementation start date	15/09/2022
Implementation end date	08/09/2023
Total budget for implementation	USD 233,825
Description of delivered outputs and products as well as the activities undertaken to achieve them. In doing so, review the log frame of the original response plan and refer to it as appropriate	**Mandatory Deliverables:** • Implementation plan • Monitoring and evaluation plan • Impact description document • Closure and Data Collection Report **Output 1: SRI Irrigation Report:** • Stakeholder mapping report containing a complete stakeholder list as well as a description of the Stakeholder Working Group (including name, position, institution, gender and role of each member). • Inception meeting report with materials, list of participants disaggregated by gender. • Diagnosis of current irrigation systems used for SRI and rice production in Liberia. • Selection of the pilot county detailed in a report and minutes of the meeting with the SWG.

	• Benchmark of most suitable international irrigation systems for SRI from countries with similar socio-economic, geographic and climatic conditions. • Report on challenges and recommendations for irrigation and rice cultivation customized to the selected county and taking gender and youth into consideration. **Output 2 & 3: SPIS Configurations Report:** • Final report on the data requested to understand the demand side of a SPIS. • Final report data requested to define a fit-for-purpose PV pump system and irrigation infrastructure (supply side). • Report defining the best configuration of the SPIS model for SRI in the selected county of Liberia. • Technology fact sheets. • Cost estimation of the prioritized technologies. • Minutes of the SWG´s workshop including the material (PowerPoint or else), list of participants disaggregated by gender, photos, conclusions. • Minutes of the global stakeholder's workshop, including the material (PowerPoint), list of participants disaggregated by gender, photos, conclusions. • Final report revised based on the comments received during the workshop. **Output 4: Implementation Report for the Small-scale Pilot of a Solar Pumping Irrigation System in Bong County:** • Report on the visit on site to the pilot area with pictures, participants, conclusions. • Detailed implementation Plan. • Report on the meeting to discuss the logistics and implementation of the pilot. • Final implementation plan including modifications requested by the SWG. • Report on the deployment of the technology by professionals with pictures. **Output 5: Bong Mines Pilot Scheme - Operation & Maintenance Manual:** • Detailed manual explaining the way to use the SPIS system and how to ensure its maintenance designed. • Minutes of the "Learn by doing" workshop with the rice farmers of the county with pictures, and a list of participants desegregated by gender as well as materials used. • Minutes of the stakeholder consultation workshop with pictures, and a list of participants desegregated by gender as well as materials used. **Output 6: Enabling Environment Roadmap and Monitoring & Evaluation Framework:** • M&E Framework. • Enabling environment roadmap.
Methodologies applied to produce outputs and products	• Desk research and analysis of relevant country policies and documents. • Stakeholder Mapping to identify key stakeholders. • Interviews and workshops with key stakeholders. • Site visits with SWG and multi-criteria analysis for selection and prioritizing pilot area and appropriate technologies.

	• Development of Implementation Plan, including Memorandum of Understanding with farmers' co-operative and contract with equipment supplier/installer. • Monitoring of delivery and installation of pilot scheme materials to site. • Capacity building workshops with farmers on development and O&M of the pilot scheme.
Reference to knowledge resources	During the project, reference was made to various TEC Briefs, Strategies and guidelines (Link to TEC knowledge database: https://unfccc.int/ttclear/tec/documents.html), in particular: • TEC Brief # 17 - Policy brief on enabling environments • TEC monitoring and evaluation framework.
Deviations	As agreed with CTCN Project Manager, and due to delays and the partial theft of the pilot scheme equipment, the following activities were not completed: • Final workshop with the municipal and national officers and training with the rice farmers on the M&E framework.
Anticipated follow-up activities and next steps	Planned follow-up included: • Development of SPIS policy and strategy for upscaling across the selected county and nationwide. Stakeholders involved: EPAL and MoA, with support from CTCN. • Monitoring and evaluation activities using the M&E Framework, to collect and analyse information from the pilot and other SPIS schemes. Stakeholders involved: MoA, with support from EPAL. • Drafting of formal funding proposals to suitable funding agencies, involving NDE with support from CTCN. Due to the theft of the SPIS equipment from the pilot scheme, CTCN's approach to funding the implementation of infrastructure through pilot schemes was to be reviewed at the CTCN Advisory Board (April 2024).

2. Lessons learned

	Lessons learned	**Recommendations**
Lessons learned from the CTCN TA process	• Development of the Response Plan was undertaken by CTCN through close collaboration with the NDE (EPAL) and the MoA, but a lack of continuity through the later stages of procurement of the TA Consultant meant there was a disconnect between the TA and the implementing partners. • Establishment of the SWG at the outset of the TA enabled the engagement with a broad range of stakeholders, but actual participation of stakeholders was limited, particularly due to poor internet connectivity in the country for virtual meetings, with key players absent from many of the key activities. • Development of pilot infrastructure at the community level requires thorough due diligence of community organisations, participatory design and implementation, and capacity building across a range of skills much broader than the core objectives of the TA.	• Ensure that the Project proponents have a good understanding of CTCN procedures, particularly in relation to procurement of network members for TA. • Include dedicated conference facilities and internet packages within the budget to ensure better communications. • Ensure compensation and allowances for workshop attendance are established and funded at the outset of the TA. • For pilot scheme implementations, provide more time and budget for engagement, due diligence and capacity building with the community members and

	Lessons learned	Recommendations
		community based organisations.
Lessons learned related to climate technology transfer	• Although many of the formal SWG meetings were hampered by poor internet, the communications with individual stakeholders provided exchange of information and experience that was very beneficial to the TA. • Stakeholders presented views of Liberia that indicated the difficulties of developing projects with rural communities and smallholders, particularly noting issues of security, a lack of commitment to and capacity for O&M and their long-term dependency on external support (These are some of the key weaknesses of the agricultural sector in Liberia). • The extensive presence of government ministries could be used as a tool to facilitate the implementation of SPIS programmes for sustainability, but they are severely constrained by their available budgets and staff capabilities. • SPIS addressed the technical constraints facing smallholder farmers, enabling increased rice production in the face of climate change impacts to a predominantly rain-fed system.	• Allow sufficient time for engagement with private sector individuals, beneficiary communities and organisations. • Invest in capacity building for beneficiary communities, particularly leadership, before piloting schemes, to ensure long-term commitment and financial and organisational capabilities for O&M and M&E. • Ensure all inputs required for commissioning at the start of operations are identified and sourced, preferably by the communities to prove their commitment, and there is adequate extension support in place (e.g. Rice seed, extension services).

3. Illustration of the TA and photos

Context: Rice Farming in Liberia

- Land preparation for lowland rice is done manually.
- Transplanting is the main method of crop establishment.
- At present, farmers generally apply little fertilizer to rice.
- Weeding is generally done manually, although the use of herbicides is increasing in irrigated rice.
- Farmers do not have adequate appropriate tools and equipment for harvesting and threshing of rice.
- The existing rice cultivation is Single crop in a year except few pockets
- The current productivity stands <2t/ha



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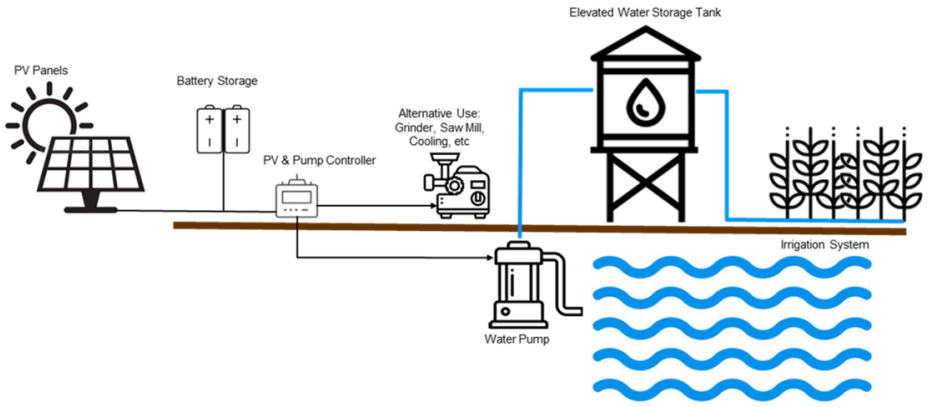
SPIS Components & Design



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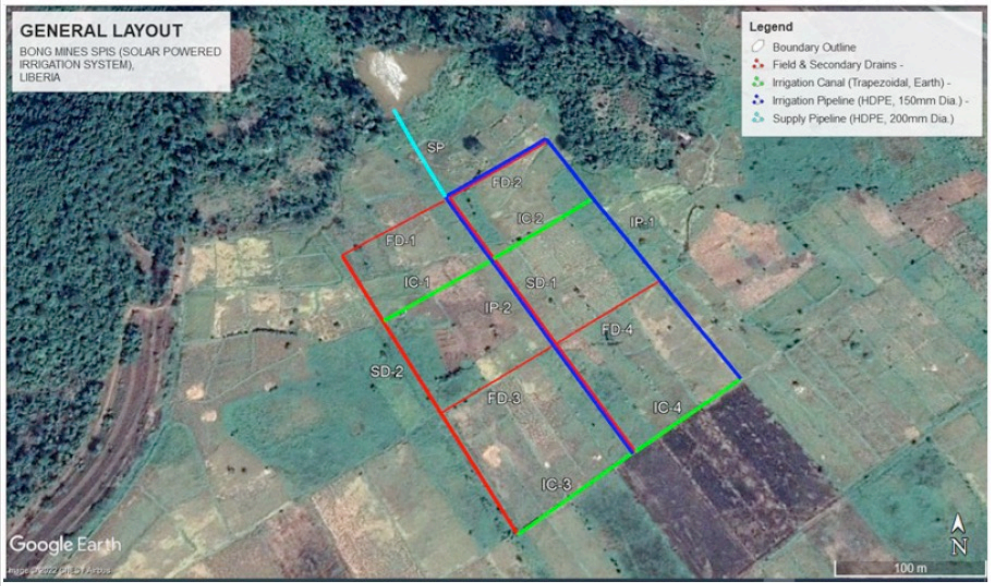

Supplier/Contractor Activities

- Supply and transportation of solar equipment and materials to site:

- Laying and jointing of pipelines:

- Panel frame support foundations and steelwork:

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4. Impact Statement

Impact Statement				
Challenge	Agriculture in Liberia is predominantly rain-fed, so climate change is threatening the sustainability of agricultural production. In response, the Liberian Government is investigating intensified rice farming, to increase rice production, whilst lowering water usage by crop-targeted drip irrigation, thereby ensuring sustainable use of the limited surface and groundwater resources, and reducing the contribution to climate change of electricity generation by pumping systems powered by solar systems.			
CTCN assistance	The TA introduced Solar Powered Irrigation Systems (SPIS) technology as part of a System of Rice Intensification (SRI) pilot in one county, using the lessons learnt to formulate an enabling environment roadmap and M&E framework for nationwide roll-out; including: • Analysis of current irrigation and rice cultivation practices • Design of SPIS technologies for SRI in Bong County • Small-scale pilot of the selected SPIS • Dissemination of training materials and workshops.			
Anticipated impact	The indicators of the numbers of direct and indirect beneficiaries (Core Impact No. 3: disaggregated by gender) have been assessed as a result of the TA and compared to the anticipated impact.			
		Men	Women & Youth	Anticipated
	Number of participants in the stakeholder engagement, training, and workshops	90	40	80
	Number of individuals directly benefiting from the pilot SPIS scheme	20	10	10-20
	Number of individuals indirectly benefiting from the pilot SPIS scheme	70	30	60
Anticipated co-benefits from the TA	Apart from the core impact indicators above there are significant co-benefits expected over the project lifetime from the TA and the Team assessed and quantified the following:			

Impact Statement	

	• Environmental co-benefits:
	  ○ Energy savings (No prior irrigation system at the pilot site)
	  ○ Reduction of air-pollution (No prior use of petrol-driven pumps at the pilot site)
	• Social co-benefits:
	  ○ Increased knowledge for climate change adaptation and mitigation
	  ○ Access to energy and water for rural households, for domestic and livestock use
	• Economic co-benefits:
	  ○ Increased food security and the improvement of livelihoods of local communities
	  ○ Job opportunities within local communities.

Gender aspects of the TA	Past experiences show that there are significant benefits of solar pumping solutions for women. It allows the women farmers to become net producers, generate income from market sales and substantially increase their household nutrition intake and food security (Burney et al., 2009). Also, gender characteristics play an important role in terms of energy decision-making (IRENA, 2016). • The TA supported achieving gender equality and the empowerment of all women and girls by the inclusion of gender in all the intended outcomes. • A gender analysis was conducted for stakeholder participation. • The SWG included two female members, out of the total eight. • Gender benefits included identifying and addressing challenges and barriers for women (and youth) in accessing small-scale irrigation systems and solar water pumping in rice cultivation.
Anticipated contribution to NDC	• Through promoting low-emissions rice cultivation, the TA contributes to Liberia's Nationally Determined Contribution (NDC) target for the Paris Agreement of reducing agricultural GHG emissions by 40% below projected business-as-usual (BAU) levels by 2030 (reduction of 13 GgCO2e) • The TA achieves the NDC target of deploying *"at least 1 solar water pump and/or spring irrigation system for crop irrigation for communal farms with land constraints in each county by 2030".*

Impact Statement	
The narrative story	Agriculture in Liberia is predominantly rain-fed, dependent on consistent rainfall, and climate change is posing serious challenges to the sector by threatening the sustainability of agricultural production in the country. In response, the Government of Liberia is investigating the adoption of irrigation for intensified rice farming, to increase rice yields in the country whilst lowering water usage by applying crop-targeted drip irrigation, thereby ensuring sustainable use of the limited available surface and ground water resources. Also, due to the high cost of electricity, irrigation water pumping is to be powered by solar systems. The objective of the TA was to introduce solar powered irrigation technology and practices to intensify rice cultivation and production in one lowland county in Liberia, to be selected between Lofa and Bong, with the intention of upscaling the technology as an adaptation measure to climate change at a national level. To achieve this objective, the TA undertook the following: • Analysis of the current irrigation and rice cultivation practices in one county of Liberia • Select and design of an appropriate irrigation and solar water pumping (SPIS) technology for SRI based farming in the selected county (Bong County) • Piloted a small-scale implementation of the solar pumping system in the selected county • Elaborated and disseminated training materials and workshops • Formulated an enabling environment roadmap and a M&E framework.
Contribution to SDGs	The TA contributes to the following Sustainable Development Goals (SDGs): • SDG1 End poverty in all its forms everywhere *Improving rice production through the System of Rice Intensification (SRI) and Solar Powered Irrigation Systems (SPIS) will increase incomes for rural farmers.* • SDG2 End hunger, achieve food security and improved nutrition, and promote sustainable agriculture *Improving rice production through SRI and SPIS will ensure food security and improved quality of life for farmers.* • SDG7 Ensure access to affordable, reliable, sustainable, and modern energy for all *By promoting the roll out of SPIS, the TA is improving the availability of affordable, reliable, sustainable, and modern energy and increasing the share of renewable energy produced.* • SDG13 Take urgent action to combat climate change and its impacts *By replacing inefficient old pumps powered by fossil fuels with PV solar power, CO_2 emissions will be reduced, energy savings will be made and air pollution avoided. SRI initiatives and SPIS infrastructure will provide resilience to climate change impacts of drought, increased temperatures, wind and consecutive dry days. Direct and indirect beneficiaries will benefit from enhanced awareness and knowledge and an enabling environment roadmap for nationwide implementation.*

Annex 1 Technical assistance data collection

A. Output and outcome indicators

Indicator Please note indicators below highlighted as **anticipated**	**Quantitative value**	**Qualitative description** *List the various elements corresponding to the quantitative value as well as timelines and responsible institutions*
Total number of events organized by proponents and implementing partners	**14**	Kick-off and Inception meetings (2) SWG meetings (6) Workshop and training (3) Site inspections/Hands-on (3)
Number of participants in events organized by proponents and implementing partners	**130**	EPAL, MoA, Fuamah District Multi-purpose Co-operative (FDMC), SWG
a) Number of men	**90**	
b) Number of women	**40**	
Number of climate technology RD&D related events		
Number of participants in climate technology RD&D events		
a) Number of men		
b) Number of women		
Number of trainings organized by proponents and implementing partners	**3**	SPIS Configurations SPIS Operations & Maintenance System of Rice Intensification (SRI)
Number of participants in trainings organized by proponents and implementing partners	**130**	
a) Number of men	**90**	
b) Number of women	**40**	
Total number of institutions trained	**3**	
a) Governmental (national or subnational)	**2**	Ministry of Agriculture EPAL
b) Private sector (bank, corporation, etc.)		
c) Non-Governmental (NGO, University, etc.)	**1**	FDMC
Percentage of participants reporting satisfaction with CTCN training (from CTCN training feedback form)		*Satisfied= 4+ on 5-pt scale*
Percentage of participants reporting increased knowledge, capacity and/or understanding as a result of CTCN training (from CTCN training feedback form)		*Increased knowledge, capacity and/or understanding= 4+ on 5-pt scale*
a) Percentage of men		
b) Percentage of women		
Total number of deliverables produced during the assistance (excluding mission, progress and internal reports)	**6**	• Mandatory deliverables • SRI Irrigation Report (Output 1) • SPIS Configurations Report (Output 2 & 3)

		• Implementation Report for the Small-scale Pilot of a Solar Pumping Irrigation System in Bong County (Output 4) • Bong Mines Pilot Scheme - Operation & Maintenance Manual (Output 5) • Enabling Environment Roadmap and Monitoring & Evaluation Framework (Output 6)
a) Number of communication materials, including news releases, newsletters, articles, presentations, social media postings, etc.	**3**	• Presentations to conferences (2) • CTCN News article
b) Number of tools and technical documents strengthened, revised or developed	**4**	• Fact sheets (5) • Pilot Scheme Tender Document and Contract • Implementation Plan • Memorandum of Understanding with FDMC
c) Number of other information materials strengthened, revised or created (For example training and workshop reports, Power Points, exercise docs etc.)	**3**	• SPIS Configurations • SPIS Operations & Maintenance • System of Rice Intensification (SRI)
Total number of policies, strategies, plans, laws, agreements or regulations supported by the assistance	**2**	• Enabling Environment Roadmap • Monitoring & Evaluation Framework
a) Adaptation related	**2**	
b) Mitigation related		
c) Both adaptation- and mitigation related		
Anticipated number of policies, strategies, plans, laws, agreements or regulations proposed, adopted or implemented as a result of the TA	**1**	Strategy for upscaling lowland rice production to improve food security through improved SPIS and SRI
a) Adaptation related	**1**	
b) Mitigation related		
c) Both adaptation- and mitigation related		
Anticipated number of technologies transferred or deployed as a result of CTCN support	**19**	• Water efficiency • Connection of isolated grid • Community-based energy services • Water pumping • Solar water pumps • Solar PV • Off-grid systems • Irrigation • Rice cultivation • Soil management • Integrated nutrient management • Soil moisture monitoring • Fertilizer management • Pest and insect control • Improved cultivation techniques

		• Crop diversification and new varieties • Crop rotation • Irrigation efficiency and information systems • Soil moisture conservation techniques
Anticipated number of collaborations facilitated or enabled as a result of technical assistance	**10**	
a) Number of South-South collaborations	**6**	• CHAP (Community of Hope Agricultural Project) • Africa Rice Center (Liberia) • Central Agric Research Institute • Liberia Rice Farmers Federation • Liberia Land Authority • Ministry of Mines and Energy
b) Number of RD&D collaborations	**3**	• Africa Rice Center (Liberia) • Food and Agriculture Organization of the United Nations (FAO) • Bangladesh Rural Advancement Committee (BRAC) Liberia
c) Number of private sector collaborations	**1**	Nation Innovations Systems (Solar installer)
Number of countries with strengthened National System of Innovation as a result of CTCN support	**1**	Liberia
Insert any additional indicators here		

B. Core impact indicators

Core indicator 1	**Anticipated metric tons of CO_2 equivalent (CO_2e) emissions reduced or avoided as a result of CTCN TA**	
	Anticipated metric tons of CO_2e reduced or avoided as a result of the TA **on annual basis**	Anticipated metric tons of CO_2e reduced or avoided as a result of the TA **in total**
Quantitative value *(emissions reductions)*		
Unit	tCO_2e	tCO_2e
GHG assessment boundary (project emissions) Identify expected post-TA activities, associated effects and assess boundary for quantification of GHG emission reductions		In other areas, where farmers currently irrigate with fossil fuel powered pumps, replacing these with PV solar power, will reduce CO_2 emissions, energy savings will be made and air pollution avoided.
Baseline emissions Describe baseline scenario, baseline candidates, emission factors and emissions calculated	Farmers at the pilot site were not previously using pumps and had no plans to irrigate, therefore GHG emissions will remain approximately the same.	

Methodology Explain the method or process of verifying the indicator and how data was gathered		
Assumptions Describe assumptions made during calculation and quantification of GHG reductions		

Core indicator 2	**Anticipated increased economic, health, well-being, infrastructure and built environment, and ecosystems resilience to climate change impacts as a result of technical assistance**
Infrastructure and built environment Anticipated increased infrastructure resilience (avoided/mitigated climate induced damages and strengthened physical assets)	5 ha pilot irrigation scheme installed, although due to theft of half of the PV panels currently inoperative.
Ecosystems and biodiversity Anticipated increased ecosystem resilience (areas with increased resistance to climate-induced disturbances and with improved recovery rates)	
Economic Anticipated increased economic resilience (e.g. less reliance on vulnerable economic sectors or diversification of livelihood)	Farmers able to cultivate two additional crops during the dry season, in addition to their usual rain fed crop
Health and wellbeing Anticipated increased health and wellbeing of target group (e.g. improved basic health, water and food security)	

Core indicator 3	**Anticipated number of direct and indirect beneficiaries as a result of the TA**	
	Quantitative value	**Means of verification**
Total beneficiaries	***130***	
Number of adaptation beneficiaries	130	Farmers benefitting directly from the scheme and those benefitting indirectly from training provided
Number of mitigation beneficiaries		
Number of adaptation-and mitigation beneficiaries		

Core indicator 4	**Anticipated amount of funding/investment leveraged (USD) as a result of TA (disaggregated by public, private, national, and international sources, as well as between anticipated/confirmed funding)**			
	Quantitative value confirmed *in USD*	**Quantitative value anticipated** *in USD*	**Qualitative description** *List the institutions, timelines, and*	**Methods** *Describe methods used for*

			description or title of the investment	*quantification of funds leveraged*
Total funding	*Total number in USD (numerals only, no rounding or abbreviations)*	*Total number in USD (numerals only, no rounding or abbreviations)*		
Anticipated amount of public funding mobilised from national/domestic sources				
Anticipated amount of public funding mobilised from international/ regional sources				
Anticipated amount of private funding mobilised from national/domestic sources				
Anticipated amount of private funds mobilised from international/regional sources				

Annex 2 (for internal use – to be filled in by the CTCN)

CTCN evaluation

This section will be completed by the relevant CTCN Technology Manager.

- Evaluation of the timeliness of the TA implementation as measured against the timeline included in the response plan;
- Evaluation of TA quality as defined in the response plan;
- Overall performance of the Implementers;
- Overall engagement of the NDE and Proponent;
- Lessons learned on the CTCN process and steps taken by the CTCN to improve.