Promoting Climate Adaptation by Upscaling Solar Irrigation Technology Options for Smallholder Farmers in Ghana through Innovative Financing Mechanisms, a Conductive Policy Framework for Technology Regulation and Tailored Training Modules

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Output 2 Deliverables Report

Prepared for:

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This document has been issued and amended as follows:

Issue	Revision	Date	Description	Prepared by	Checked by	Approved by
1	0.0	2 May 2024	Issued to Client for comment	AK	OT	OT

Contents

Acronyms and Abbreviations

AfDB	African Development Bank
AIICO	Agriculture Infrastructure Investment Company
AWD	Alternate Wetting and Drying
CAC	County Agriculture Coordinator
CAO	County Agriculture Officer
CARI	Competitive African Rice Initiative
CHAP	Community of Hope Agriculture Project
CTCN	Climate Technology Centre and Network
DAO	District Agriculture Officer
DOA	Department of Agriculture
EIA	Environmental Impact Assessment
EPA	The Environmental Protection Agency of Liberia
FAO	Food and Agriculture Organization of the United Nations
FED	Food and Enterprise Development Programme
FUN	Farmer Union Network
GAP	Good Agricultural Practices
GIS	Geographic Information System
LIGIS	Liberia Institute of Geo-Information Services
M&E	Monitoring and Evaluation
MoA	Ministry of Agriculture
NDE	National Designated Entity
NGO	Non-Governmental Organisation
PV	Photovoltaic
RAC	Region Agriculture Coordinator
SPIS	Solar Powered Irrigation Systems
SRI	System of Rice Intensification
SWG	Stakeholder Working Group
TA	Technical Assistance
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization (UNIDO)
USAID	United States Agency for International Development
WAAPP	West Africa Agricultural Productivity Program
WARDA	West Africa Rice Development Association
WUA	Water User Association

1 Introduction

Background

The project "Promoting Climate Adaptation by Upscaling Appropriate Solar Irrigation Technology Options for Smallholder Farmers in Ghana through Innovative Funding Mechanisms, a Conductive Policy Framework for Technology Regulation and Tailored Training Modules" is a UN CTCN (Climate Technology Centre and Network) project. CARES Ghana, in association with INTEGRATION energy & environment (the Consultant) offered to provide Technical Assistance (TA) for the project and were awarded a Contract (UNEP- CTR-4700023676-CTCN Ghana) on 26th August 2022 to carry out the assignment.

Objective of Assignment

The objective of the TA is to promote smallholder farmers' adaptation to climate change by providing a sustainable and efficient means of irrigation through the assessment of solar technology options, design of an appropriate and sustainable business model for the lowest income, and formulation of a policy framework for the use of Solar Powered Irrigation System (SPIS) in Ghana. This will include the following outputs:

I. **Output 1:** Benchmark Solar Powered Irrigation technologies suitable to smallholder farmers in Ghana and assess their respective cost-benefits**.**
II. **Output 2:** Define a business model targeting smallholder farmers for the use of Solar Powered Irrigation Systems in Ghana, with recommendations on financing structures to extend credit and reach the unbanked smallholder farmers
III. **Output 3:** National framework on Solar Powered Irrigation technology, to drive the setting of standards and certification that will support the deployment of a local market
IV. **Output 4:** Capacity training to raise awareness on the benefits of Solar Pumping Irrigation Systems for smallholder farmers in Ghana, targeted at the users and administrators of the technology across the supply chain to support its sustainable use and long-term maintenance.

The TA focusses on SPIS that builds on existing hard technology options in the country, and soft technology solutions that create an enabling environment for the uptake and dissemination of the technology (policy, training, and financing). The TA will ensure the involvement of financial institutions including micro finance institutions, rural banks and non- bank entities that could participate in the provision of financing services for smallholder farmers. The financing structures will consider appropriate risk mitigation instruments including insurance and guarantee structures aimed at crowding in private sector investments. Implicit for a successful financing structure is the aggregation of smallholder farmers to increase the scale of the opportunity.

Report Outline

This Report brings together all the deliverables for Output 2 of the TA, as follows:

I. Report of the stakeholder meeting with list of participants disaggregated by gender, photos and materials used
II. SWOT analysis of the access to financial mechanisms from smallholder farmers for the purchase of solar pumping irrigation system
III. Needs of the farmers / needs of the financial institutions
IV. Business models targeting smallholder farmers for SPIS with their respective SPIS architecture
V. Minute of Stakeholder Business Model Validation Workshop.

I. Stakeholder Meeting (13th April 2023)

Date: 13 April 2023

Location: Airport West Hotel's Conference Room, located on N Airport Road, Airport Residential Area, Accra.

Attendees:

See attached Attendance Sheet

Minutes

1. **Participants welcomed from 09:30am.**
   - The start was delayed due to problems with the communications and media systems. The meeting started at 10:30am.
   - NDE gave introductions, followed by round table introductions by all attendees, including those on-line.

2. **Introductory remarks**
   The Associate Director of CARES Ghana gave the introductory remarks.

3. **CARES/INTee made a presentation of the Technical Assistance project (Attached PDF), including:**
   - Project Aims & Objectives
   - Outcomes:
     I. Benchmark Solar Powered Irrigation Technologies Suitable to Smallholder Farmers in Ghana and Assess their Respective Cost-Benefits
     II. Define a Business Model Targeting Smallholder Farmers for the Use of Solar Pumping Irrigation Systems in Ghana
     III. National Framework on Solar Powered Irrigation Technology
     IV. Capacity Training to Raise Awareness on the Benefits of Solar Pumping Irrigation Systems for Smallholder Farmers in Ghana
   - Context in Ghana:
     - Agriculture, Livelihood and Smallholder Farming
     - Climate Change
     - Irrigation
   - SPIS Opportunities, Technologies, and Constraints
   - Financial Barriers
   - Risk Mitigation for Financial Institutions
   - Potential solutions.

- **Discussion - Reactions/clarifications/exchanges with attendees**

- Morning Session:

  - The presentation section on total current versus total potential irrigable area, which could be unlocked with the introduction of SPIS technology, was supported by GIDA saying there are up to about 1.9 million hectares of irrigable land available in Ghana.
  - On a question to the extent of coverage of the SPIS financing project, it was explained that though the study is restricted to the coastal and northern savannah zones of Ghana the roll out would cover the whole country.
  - On the cost of the SPIS it was explained that the project is not meant for implementation, but rather gathering data for the design of a suitable business plan for

smallholder farmers.

- A participant wanted to know if smallholder farmers the existing GIDA irrigation projects also qualify to be considered under the project, and answer was yes.
- In his contribution, a participant from the Energy Commission said the promotion of SPIS had been already captured by the Ministry of Energy, and the Energy Commission had also developed eleven (11) standards for the solar pump system awaiting approval from the GSA.
- On the question of the nature of support the project wants to give to the smallholder farmers, it was explained that the project is aimed mainly at empowering farmers across the country to adapt to solar powered technologies in irrigated agriculture, and also finding an appropriate financing mechanism to enable them to own the SPIS system.
- The participant from ARB Apex Bank hinted that the project should look at the VSLA (village savings and loans associations) system as a model.

- Afternoon Session:

  Due to technical difficulties in linking up with online participants, the presentation for the afternoon session on financial barriers to uptake of SPIS was recorded and sent in from Germany by INTee.

  - Referring to the "SPIS vs. value chain financing" proposal in the presentation, one participant said it would have been more relevant if all the actors along the value chain were present at the meeting and had advised that they are brought together in future.
  - Concerning the operation of guarantees to derisk transactions, some of the institutions unfortunately have preferred faces that they extend their guarantees to.
  - The completed Rural Enterprises Project, was mentioned by a participant, saying they used to have technology solution centre, apart from business advisory centre, which would be appropriate to assist in developing the SPIS. There is a follow-up project that the TA can approach.
  - Dealing with rural banks (e.g., Toende Rural Bank, Upper East Region) that provide cashless loans (physical agricultural inputs only) to farmers is another model practised in the north.
  - A comment was made as to whether the smallholder farmer needed *water* or *irrigation equipment* to produce – if water, then this must be taken into consideration as the business model is being developed.
  - The financial institutions' risk factor of uncertainties on rainfall for rainfed agriculture that compels them from giving loans to smallholder farmers is a mindset that must be changed because there is assurance of water available in dams or rivers, and the only thing that the farmer needs is a solar irrigation system to farm. So, the banks must reconsider and give credit to farmers, especially those operating near reliable sources of water, to own the solar irrigation facilities.
  - GIDA's new model for pumped irrigation schemes is to enter into agreement with an independent solar power provider to install the solar energy system on a BOT (build, operate and transfer) basis. The rates paid by the farmers are far lower than those charged by the ECG (Electricity Company of Ghana). When farmers are in organised groups, it is easier to find solutions to give them irrigation water.

III. SWOT Analysis and Needs of Farmers / Financial linstitutions

SWOT Analysis of the Access to Financial Mechanisms for Funding SPIS Investments in Ghana

INTERNAL

STRENGTHS	WEAKNESSES
▪ Technically mature: ○ Solar power provides reliable and affordable energy for irrigation - Correlation of resource supply with demand, as crop water demands increase with solar irradiance and energy production ○ Easy to install, manage and maintain and low maintenance, especially in remote rural areas where diesel fuel is expensive or there is no access to an electricity grid ○ Flexible and climate-friendly alternative energy source with no regular fuel costs nor volatility of fuel prices ○ Environmentally sound - Noise and CO_2 emission reductions, compared to diesel pumps ○ Highly reliable - SPIS can also be low maintenance and have a relatively long lifespan ○ Increased harvests due to optimized crop water availability. ▪ Becoming more economically competitive - Reducing capital costs for SPIS equipment is making it a more viable adaptation option for smallholder farmers ▪ Government policies encourage SPIS (e.g. Customs duty and VAT exemptions on imported equipment) ▪ Financial products and services have been designed for smallholder farmers: ○ Venture capital funding for smallholder servicing is available in Ghana ○ Green People's Energy Project (GPEP) funded by GIZ with incentive/subsidy paid to farmers (40% for men, 50% for women) and ticket/project size from GH₵50,000 to GH₵80,000 per system. ▪ Farmers are willing to pay back investment capital after harvest.	▪ Without land ownership there is no incentive to invest in SPIS (Investing in SPIS becomes costly if farmer must relocate after a few years) ▪ Still relatively high initial investment costs compared with diesel pumps - Water storage is required to account for cloudy periods, adding to initial Capex cost ▪ Farmers and extension services are not aware of the variety of new technologies that are appropriate for them - SPIS are relatively new, therefore farmers have limited access to distributors for installation, parts, and service (Distributors are concentrated in Accra and mainly distribute in local areas) ▪ Quality is not always assured - Absence of an integrated equipment supply chain and certification standards ▪ Target for theft of equipment ▪ Solar industry is still new and lacks standardized and suitable financing mechanisms: ○ High prime rate from the central bank (up to 40%) ○ Financial products and services are often not practical for true smallholder farmers, including a lack of robust and consistent evaluation criteria in line with the realities of smallholder farming, leading to higher administrative and transaction costs (e.g. paperwork, credit checks and other due diligence activities, as banks have to develop new processes and procedures for each new project they finance) ○ Thresholds for venture capital funding for smallholder servicing is far above the farmer´s capacity (Requirement of minimum equity, approx. 20%, is often unrealistic for farmers). ▪ Few farmers have bank accounts, with no collateral, credit history, financial statements etc, which lenders require for creditworthiness checks and therefore unable to access to credit/finance ▪ Farmers are unable to make regular repayments, except after harvests: ○ Farmers not sensitized to saving adequate money for O&M expenses, needing for additional loans for repairs and maintenance (Lack of finance for OPEX) ○ Mind-set/attitude of farmers is that government or NGO backed finance is provided as a grant, rather than a personal loan to be repaid. ▪ Government budgets are stretched and focus on large, formal schemes rather than smallholder farmers ▪ Lack of simple maintenance leads to reduced output (e.g cleaning panels, yearly checks on the pump and power controller) – Small issues lead to months of shutdown and loss of revenues ▪ Most grant-based donor programmes have not left behind a sustainable financing solution to increase the reach of SPIS outside the programme areas.

	OPPORTUNITIES	THREATS
EXTERNAL	▪ Falling PV-module prices are improving the economic competitiveness of SPIS ▪ Electricity can be used for other purposes in the off-season with relative ease ▪ Potential micro-market for excess water ▪ Development of markets for SPIS, leading to employment creation (e.g. technicians, spare parts shops) ▪ Reduced imports due to increased local production ▪ Energy independency in case of failure of conventional energy sources ▪ Group farming options for smallholder farmers to work collectively to implement scaled-up SPIS solutions, with lower unit costs, both Capex and Opex, insurances and addressing credit availability issues for financing ▪ Shading under PV panels for shelter or crop protection ▪ Formation of innovative platform to discuss resource needs of all actors (i.e. Water, Land and Environment, VRA/Ghana) ▪ Gov´t / Donor Agency ownership of SPIS infrastructure to provide the farmers with water and charge water-user fees ▪ Farmers open bank accounts and change mind-set/attitude from subsistence towards commercial farming, understand the technology and optimise O&M for prompt loan repayment ▪ Restructuring existing loans to account for the project size and duration of the project cycle to reduce the cost of borrowing and the risk of default ▪ New modes of payment (i.e. technologies and interval of instalments) ▪ Financial institutions increase awareness of performance, build quality and the frequency and causes of breakdowns etc, giving them greater confidence to lend into the sector.	▪ Insufficient enabling policies and institutional frameworks: ○ No formal structures and guidelines for nucleus farmers and other smallholder collaboratives to aggregate their farms and implement efficient, large-scale SPIS ○ No standards for equipment certification ○ No equipment subsidies targeted at manufacturers providing equipment for smallholders ○ Limited access to markets for smallholder produce. ▪ Lack of awareness and trust, by both the smallholder farmers and financial lending institutions, of the benefits of SPIS (i.e. Low OPEX, reduced fuel costs, improved water availability) and the requirements (i.e. water demand calculations) ▪ Inefficient and costly design (i.e. Incorrect calculation of water demands leading to oversized systems and unused capacity) ▪ High cost of finance due to economic inflation and oil price, making service debt difficult and payback in foreign currency more challenging ▪ Faulty installation (e.g. direction of panels, tilt angle, shading, wiring, etc.) and lower quality and uncertified equipment sold to smallholder farmers without guarantees or maintenance contracts ▪ Limited O&M in rural areas, where access to technical expertise/and skills and supply chains for spare parts are not readily available ▪ Lack of monitoring, leading to potential overuse of water resources, as pumping considered to be “free” ▪ Risk of theft (panels etc.) ▪ Mind-set/attitude of farmers continues that government or NGO backed finance is provided as a grant, rather than a personal loan to be repaid ▪ Difficulties for banks to evaluate the viability of small solar projects and to develop specific financing products (Banks’ attitude to giving loans to farmers continues to expect short repayment periods) ▪ No easy system available for risk assessment and evaluation of credit worthiness of the smallholder farmers, leading to uncertainty ▪ Farmers access credit through informal loans from family members and co-operative credit groups, leaving them vulnerable to mismanagement ▪ Social barriers to pooling resources and financing a single large pump across multiple farms (issues with land usage, water availability, etc.).

IV. Business Models

Business Cases for Solar Pumping Irrigation System in Ghana

Table of Contents

Introduction to the Business Models

Business Case

Problem Statement	Ghana's agricultural sector, pivotal to its economy, is predominantly reliant on rainfed agriculture and diesel-based irrigation systems. As climate change intensifies, this reliance poses significant risks to food security and economic stability. Solar irrigation presents a promising solution, yet its adoption remains limited, primarily due to financial constraints and lack of awareness.
Proposed Solution	A solar pumping irrigation system (SPIS) is a technological solution for pumping water using solar energy. The system consists of a pump, solar panels, water storage tank and Irrigation infrastructure. In Ghana the SPIS is used by farmers to pump water from surface or underground sources and use it for agriculture. The business cases proposed here are strategically focused on upscaling the adoption of solar energy in irrigation practices. This initiative is particularly targeted at smallholder farmers in Ghana, aiming to transform traditional farming methods by integrating renewable energy solutions that are sustainable and economically viable.
Value Proposition	The goal is to empower smallholder farmers and contribute to sustainable agricultural practices by adapting solar pumping irrigation systems and making the transition financially viable for investors and customers. The business models present detailed comparison of systems and financial viability of the introduced solar powered technology.
Ownership model	Different ownership options are considered: ownership by community of farmers, operator/investors and shared ownership
Payment Modality	There are two primary payment options available, each designed to accommodate different financial or operational preferences: • **Rental Option**: Farmers can rent the SPIS technology, which allows them to utilize the system for a period of time against a rental fee. This fee structure facilitating access without the upfront cost of purchase. • **Purchase Option**: Alternatively, farmers may choose to purchase the SPIS technology outright. This investment grants them full ownership of the system, offering long-term benefits and the potential for greater economic returns through sustained use and crop production efficiency
Cost Structure	The capital investment for solar irrigation equipment includes cost for: • solar panel, • water pump, • storage system, and • irrigation infrastructure
Partnerships	• Equipment and spare parts suppliers • Electricians for repairs • Banks and financing institutions • Farmer associations
Conversion challenges	• Requirement for maintenance and operation capacity building makes • Limited availability of spare parts and accessories • Social constraints and untrust towards new technologies • Lack of initiative for investment

General Modelling Conditions

- Areas of 0.2, 0.5, 1, 5, 10, 15, and 20 ha are considered as the target groups are small holder farmers
- Typical SPIS System designs were based on Basket of crops per region
- 90% and 40% Irrigation Efficiencies assumed for Drip and Surface/Flood systems, respectively, with Drip lines replaced every 2 Years with 25% capacity.
- Total dynamic head is assumed to be 10m for purposes of standardization and ease of comparison
- PV panels sized to 150% of pump capacity to allow adequate power generation during early morning and evening hours as well

Modelling Parameters

- The model considers a project lifetime of 10 years
- Value added tax of 15% is considered as current market case
- Debt Interest rate of 30% is considered as current market case

Target KPIs and Modelling Scenarios

Target KPIs

Payback period	< 8 years
Equity Return on Investment	> 15 %
Min. DSCR	1.0

Modelling Scenarios

	Debt Interest Rate	VAT
Base Case	30%	15%
Low Interest	15%	15%
Low Interest & No VAT	15%	0%

Business Case 1 – Community Ownership Model

Main Features

Small holder farmers pool together as a community for putting up equity investment (up to 15%) and manage the systems on thier own to **eliminate margin of 3rd party operator**, while getting pressional support for larger repairs.

Farm size	Small	Up to 1 ha	
Ownership	Farmers	Operator	Other
Financing	Equity 15%	Debt 20%	Grant 65%
Tariff	1 ha farm	~ 300 $/ha/season	
KPIs	15% equity IRR	8 yrs payback	

Financing aspects

- Farmers pool in resources to purchase the SPIS as a community
- Operational margins of 3rd party operator avoided enabling farmers to benefit from lower tariffs
- Community may require support in getting access to debt finance

Implementation aspects

- Farmers might still require techncial assistance in installation and comissioning of systems
- Community can jointly decide on optimal location of the assets

Operational aspects

- Relatively small system sizes allows local technicans to be trained easily for regular O&M
- Still, there would be need for regional techncians / service providers for major repairs and replacements

SWOT Analysis

Strenghth

- Collaboration within the community to pool capital investments, overcoming a significant hurdle for smallholder farmers
- Farmers owns the system and hence they can themselves decides the tariff

Weakness

- Farms in community have to be physically close to each other
- Need for regional technician/service provider for major repairs and replacements

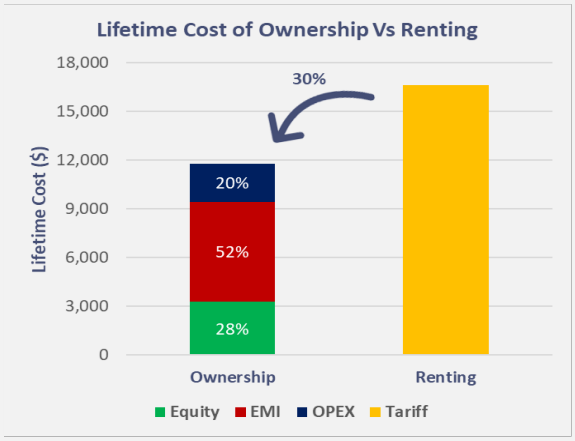
Opportunities

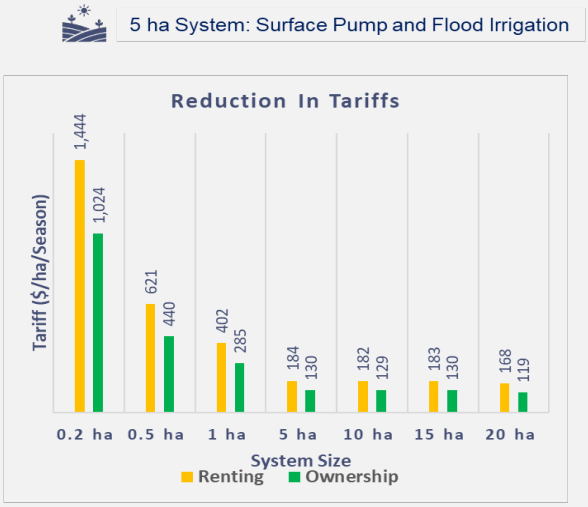
- Farmers can avoid third party margin of operator
- Group farming options for smallholder farmers to work collectively to implement scaled-up SPIS solutions, with lower unit costs, both CAPEX and OPEX, insurances and addressing credit availability issues for financing

Threats

- Faulty installation (e.g. direction of panels, tilt angle, shading, wiring, etc.) and lower quality and uncertified equipment sold to smallholder farmers without guarantees or maintenance contracts
- Lack of monitoring, leading to potential overuse of water resources, as pumping considered to be “free”
- Mind-set/attitude of farmers continues that government or NGO backed finance is provided as a grant, rather than a personal loan to be repaid

Overall Base Case Financials





- Debt repayment & interest form the major part of the life cycle system costs in ownership model
- Farmers can save upto 30% in lifetime costs (discounted over 10 years) if they bring in own equity

- Reduction in lifetime cost translates to lower tariffs for farmer
- Potentail to reduce tariff from upto 130$ for 5ha system

Example Business Model Dashboard

System Configuration

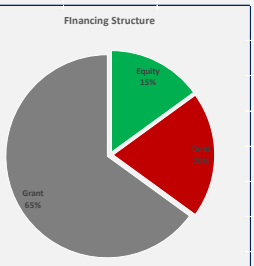
Item	Item	Value
	Solar PV	1.05kW
	Pump	0.7kW
	Storage System	7m3
	Irrigation Network	Drip
System User	Farmer	
System Type	Surface	

Overall Performance

Indicator	Value	Unit
Project NPV	3,883.52	$
Equity NPV	11,388.82	$
Equity Investment	1,669.54	$
Discounted EMI	3,131.84	$
Discounted OPEX	881.55	$
Cost of Ownership	5,682.93	$

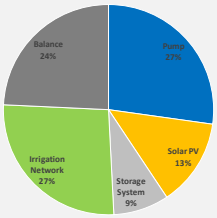
Financing Structure

Source	Value ($)	%
Equity	1,670	15%
Debt	2,226	20%
Grant	7,235	65%
Total	11,130	100%



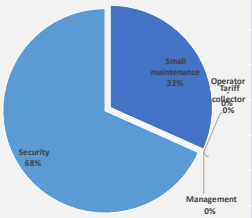
CAPEX

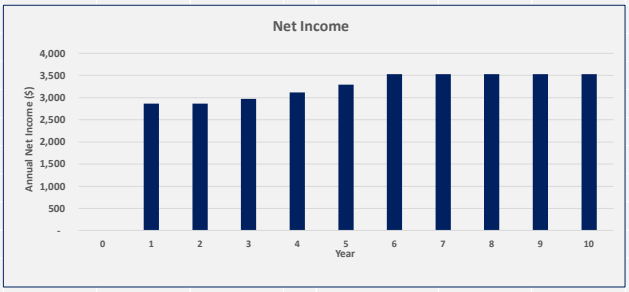
Item	Value ($)	%
Pump	3,029	27%
Solar PV	1,496	13%
Storage System	950	9%
Irrigation Network	2,955	27%
Balance	2,700	24%
Total	11,130	100%

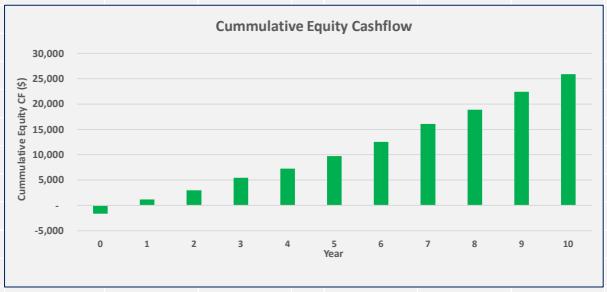


OPEX

Item	Value ($)	%
Small maintenance	56	32%
Operator	-	0%
Tariff collector	-	0%
Management	-	0%
Security	120	68%
Total	176	$







Business Case 2 – Operator Ownership Model

Main Features

3rd party investors form larger systems by pooling in small holder farmers to **achieve economies of scale**. The investor also operates the system and is responsible for O&M and tariff collection.

Farm size	Medium & Large	From 1 ha	
Ownership	Farmers	Operator	Other
Financing	Equity 15%	Debt 20%	Grant 65%
Tariff	5 ha farm	~ 350 $/ha/season	
KPIs	15% equity IRR	8 yrs payback	

Financing aspects

- 3rd party investors form pools of farmlands to increase ticket size for easier access to debt financing
- Companies can become more professional and efficient as they grow thier portfolio and can leverage for better financing deals

Implementation aspects

- Investor (who is also the operator) installs the system
- Community can contribute by providing land and in-kind support (labor) in exchange for leverage in tariff negotiations

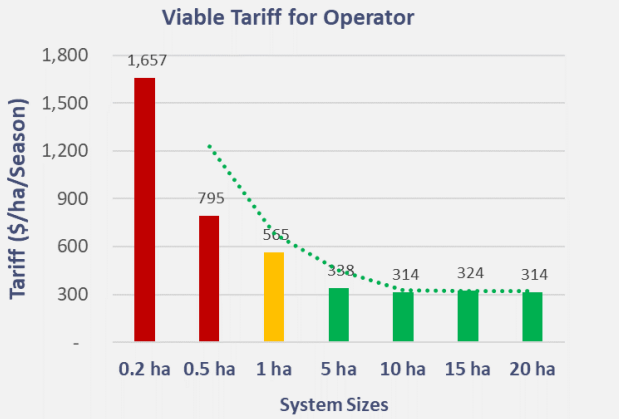
Operational aspects

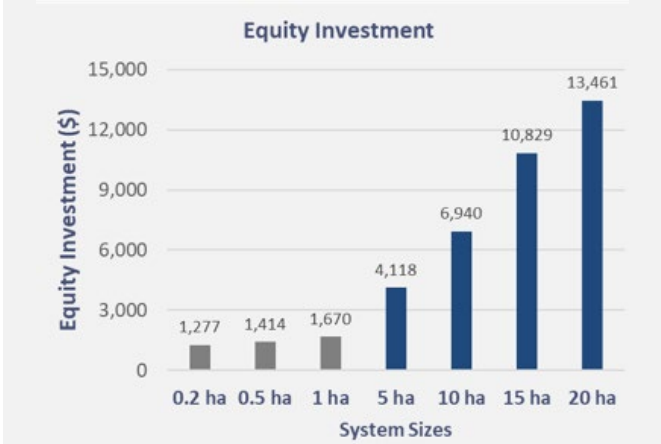
- Professional O&M teams of operator can be trained on a regional basis to optimise costs
- Farmers might be dependent on quick response if breakdowns happen during crticial irrigation periods

SWOT Analysis

Strenghth	Weakness
• Small holder farmers can join without needing any upfront investments • Third party investor and operator has strong incentive to make the systems cost efficient and manage them sustainabily to recover investments and optimize on returns	• Additional costs and margins of the thrid party operator translate into higher tariffs for farmers • Locations that are far away or places where sufficient number of farmers do not join the scheme maybe at a disadvantage while securing an investor/operator
Opportunities	**Threats**
• Third party operator can secure debt fianncing at attractive rates if the ticket size can be increased by bundling projects in portfolio • Scaling up of SPIS across the country can be promoted faster as professional operations will enhance overall confidence in the business models	• Lack of ownserhip by farmers may lead to un-sustainable use of assets • Farmers maybe tempted in subsequested years to revert back to rain fed farming or diesel pump based water supply if the other options become more cheaper

Overall Base Case Financials





- Significant reductions in tariffs are realistic only for systems from 1 ha onwards (preferably from 5ha)

- Beyond 5 ha, equity CAPEX injections become prohibitively large for farmers
- We therefore need 3rd party investors who can then also raise correspondingly large debt financing

Example Business Model Dashboard

System Configuration

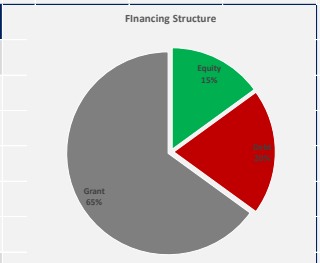
Item	Item	Value
	Solar PV	2.7kW
	Pump	1.8kW
	Storage System	30m3
	Irrigation Network	Drip
System User	Operator	
System Type	Surface	

Overall Performance

Indicator	Value	Unit
Tariff	350	$/ha per season
Project NPV	-16,322.84	$
Equity NPV	744.44	$
Project IRR	2%	%
Equity IRR	18%	%
Equity Payback	7	Years

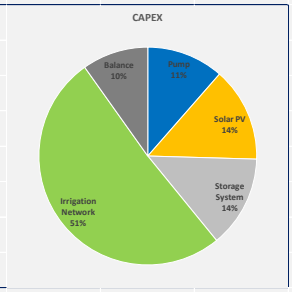
Financing Structure

Source	Value ($)	%
Equity	4,118	15%
Debt	5,491	20%
Grant	17,845	65%
Total	27,455	100%



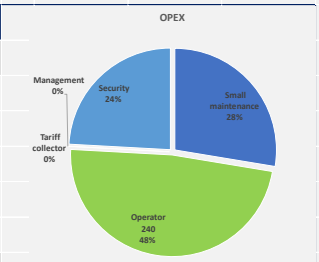
CAPEX

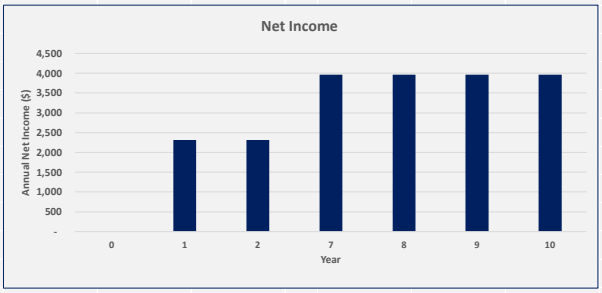
Item	Value ($)	%
Pump	3,142	11%
Solar PV	3,848	14%
Storage System	3,750	14%
Irrigation Network	14,015	51%
Balance	2,700	10%
Total	27,455	100%

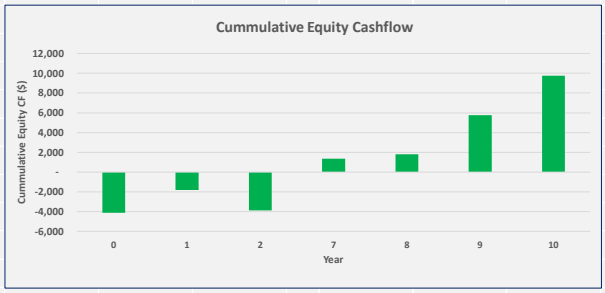


OPEX

Item	Value ($)	%
Small maintenance	137	28%
Operator	240	48%
Tariff collector	-	0%
Management	-	0%
Security	120	24%
Total	497	$







Business Case 3 – Shared Ownership Model

Main Features

Farmers and 3rd part investors both bring in equity investment to **reduce (or posibility eliminate) debt financing** which is the major burden on tariffs. Additionally other entities (e.g. Government) can support by interest by-back schemes (as a form of subsidy).

Farm size	All sizes	From 1 ha	
Ownership	Farmers	Operator	Other
Financing	Equity 35%	Debt 20%	Grant 65%
Tariff	5 ha farm	~ 150 $/ha/season	
KPIs	15% equity IRR	8 yrs payback	

Financing aspects

- 3a – Farmers and 3rd party investors both contribute equity to eliminate debt
- 3b – Other entities (e.g. Government) supports by paying off the interest on debt and potentially become part owners

Implementation aspects

- Investor (who is also the operator) installs the system
- 3a - Community contributes by providing land and in-kind support
- 3b - Other supporting entities can monitor implemention and demand specific measures for quality control

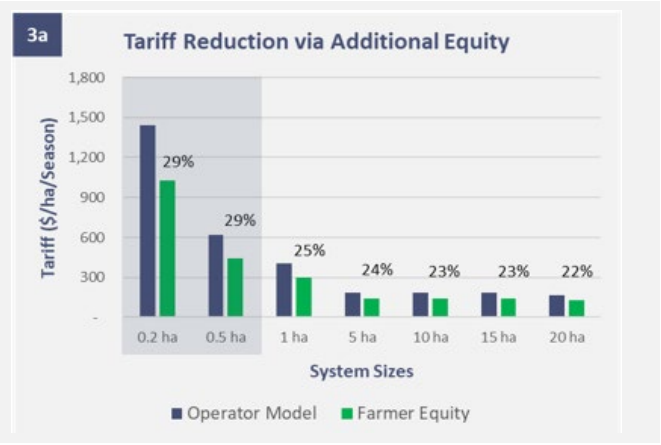
Operational aspects

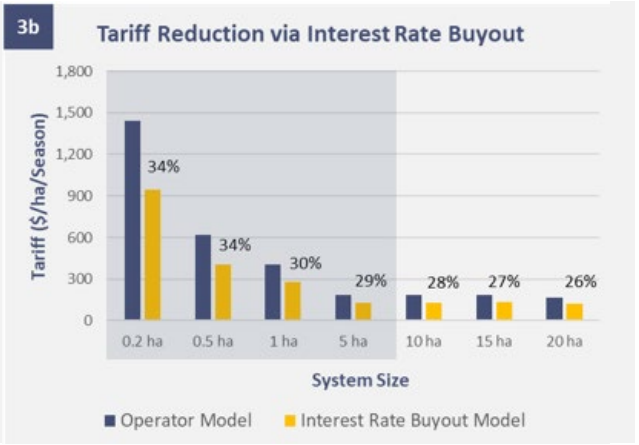
- Professional O&M teams of operator can be trained on a regional basis to optimise costs
- Farmers have co-ownership leading to more sustainable utilization of assets

SWOT Analysis

Strenghth	Weakness
• Co-ownership promotes joint sense of responsibility leading to sustainable utilization of assets • Farmers can hold the operator responsible for quick repairs in case of breakdown etc as they are able to influence the profit sharing	• The business model might be cumbersome to set up from regulatory and contractual perspectives • Need for an arbitration mechanism to resolve any potential conflicts on contractual matters, particularly related to financial audits and profit sharing
Opportunities	**Threats**
• More flexible business models can be developed suiting particular combination of communities and investors • Government or other NGOs etc could potentially also play a role and support in bridging the viability gap of the projects by providing either low interest loans, buy back interest schemes or come in as equity investors etc.	• More cumburesome implementation process may discourage investors to pursue this business model • Need to reliance on multiple farmers to join the scheme maybe increase the risk profile of the projects and maybe lead to investors asking for higher premiums or avoid risky locations

Overall Base Case Financials





- 3a – Farmers and Operator (3rd party investors) contribute equity to get rid of debt
- 18-20% Life cycle cost reduction for farmers
- Suitable for small sizes as farmers can also manage equity injection required

- 3b – Support for interest rate byout (via Government or other entities) can have a big impact in reducing tariffs for even medium size systems
- The supporting agency can also share ownership and maintain better transparency on operational sustainability

Example Business Model Dashboard

System Configuration

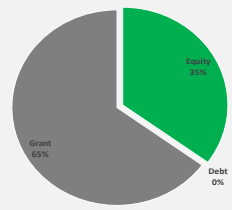
Item	Item	Value
	Solar PV	2.7kW
	Pump	1.8kW
	Storage System	30m3
	Irrigation Network	Drip
System User	Operator	
System Type	Surface	

Overall Performance

Indicator	Value	Unit
Tariff	290	$/ha per season
Project NPV	-15,693.64	$
Equity NPV	-860.64	$
Project IRR	2%	%
Equity IRR	13%	%
Equity Payback	7	Years

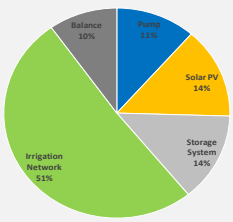
Financing Structure

Source	Value ($)	%
Equity	9,609	35%
Debt	-	0%
Grant	17,845	65%
Total	27,455	100%



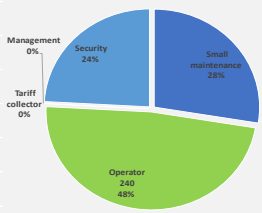
CAPEX

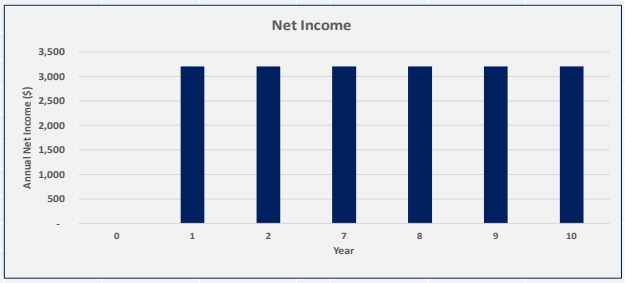
Item	Value ($)	%
Pump	3,142	11%
Solar PV	3,848	14%
Storage System	3,750	14%
Irrigation Network	14,015	51%
Balance	2,700	10%
Total	27,455	100%

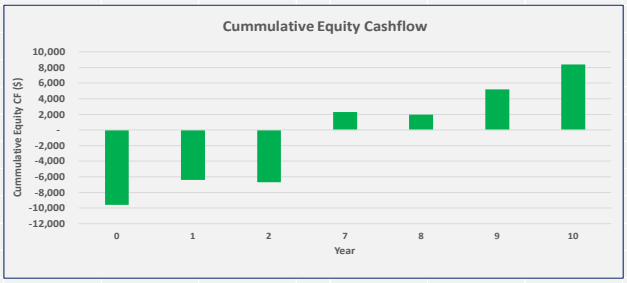


OPEX

Item	Value ($)	%
Small maintenance	137	28%
Operator	240	48%
Tariff collector	-	0%
Management	-	0%
Security	120	24%
Total	497	$







V. Business Model Validation Workshop (18 April 2024)

Date: 18th April 2024

Location: ALISA HOTEL, Conference Room, North Ridge, Doctor Isert Street, Accra.

Attendees: See attached Attendance Sheet.

Minutes

4. Participants were welcomed from 09:30am.

The meeting started at 10:00am, after majority of participants finally arrived.

5. Introductory remarks

The Associate Director of CARES Ghana, Oliver Taylor, gave the introductory remarks. He said the Technical Assistance is being sponsored by the UN CTCN (Climate Technology and Network Centre), and introduced Sharone Molly from the CTCN office participating online from Kenya and a representative from EPA/UNEP asking them to welcome the attendees to the meeting. He also informed that the meeting was being recorded and the presentation would be made available to all participants later. He also acknowledged the presence of Imran Muhammad and Rushabh Jain from INTEGRATION, environment and energy (INTee), who did much of the work on the financial modelling.

Round table introductions by all attendees, including those on-line, were made. Oliver then summarised the Agenda for the meeting and then asked Rushabh to start with the presentation.

6. CARES/INTee made a presentation of the Technical Assistance project (Attached PDF), including:

The presentation was done in three sessions:

- SESSION 1 - Introduction to Financial Model
  - Modelling Framework
  - Introduction to financial model
  - Modelling assumptions
  - Modelling parameters and Scenarios
- SESSION 2 - Modelling Results
  - Analysis approach
  - Operator perspective results
  - Farmer perspective results
- SESSION 3: Conclusions & Recommendations.
  - Key observations
  - Recommendation on Business Cases
  - Other Considerations

Presentation Summary:

Morning Session

- The framework adopted throughout the modelling was shown to include land, water resources and basket of crops.
- From the basket of crops was derived the energy demand.

- It was essential to check the viability of the project and find the most cost-effective solution.
- The dashboard gave the overview of the project selected on site; asset involved and CAPEX for the asset.
- A flexibility section was included for providing inputs.
- Assumptions made under the modelling were mentioned.
- Economies of scale showed that there was a significant CAPEX reduction, about 50% for larger systems over smaller systems, whilst irrigation network became more expensive in larger systems, as the farm area increases.
- Similarly, OPEX decreased as farm size increased, indicating economies of scale where larger farms have lower operational costs per unit of land.
- Results showed encouragement of community farming approach where smallholder farmers come together to pool their resources to operate larger farm systems.

Afternoon Session

- From observations in the morning presentation, three business cases were recommended – (i) Community business model, (ii) Operator ownership model, and (iii) Shared ownership model.
- 30% savings in revenue if system is community-owned (case 1) as compared to renting from a third party. This case is more suitable for farm sizes of less than 1ha, whilst case 2 would be more suitable for sizes beyond 5ha.
- Significant reductions in tariffs are realistic for sizes larger than 1ha.
- Third party required to inject capital into CAPEX for sizes larger than 5ha, since it would become very difficult for farmers to raise funds.
- The more innovative case 3 would be more successful if other entities, such as government, would be willing to support and become part owners of the system.

7. Discussion - Reactions/clarifications/exchanges with attendees

- *Larry Marcus (CAG)* wanted the TA to also model for a 10% Debt Interest Rate and zero VAT as a base case for the modelling scenario. Rushabh responded, saying that though the model could test such a scenario, it was not yet done since the TA wanted to use certain figures to simplify the explanation of the modelling system.
- *Edwina Quist (MOFA)* wanted explanation on how smallholder farmers with land sizes as low as 0.2ha could afford to own SPIS system at a cost of US$11,200. The response was that the figure as shown was to indicate the cost component that was considered in the modelling, and the next steps would be to discuss the different perspectives and business models that would be proposed to enable the smallholder farmers to meet such high costs.
- *Larry Marcus (CAG)* again asked about the total project lifespan assumed in the model, and the answer was 10 years, as indicated in one of the slides.
- *Prosper Glitse (GIDA)* intimated that rice under flood irrigation system is not a viable combination under the proposed model for these reasons: (i) rice has the least revenue compared to the high-value crops, (ii) efficiency of flood irrigation is low compared to drip, which is not used for rice cultivation. Oliver responded saying that the farmer would not be restricted to selecting any particular crop for a certain technology, but rather the purpose of modelling is to look at the range of crops and technologies that could be employed to see the most viable system. Imran also contributed, saying that one other factor in comparing traditional system of farming to the SPIS system is that, with the latter, the smallholder farmer can grow multiple crops, including high-value crops during the dry season.
- *Bright Asante (GIDA)*, reacting to an issue on growing rice under solar energy, said

cultivation of the crop presently at Aveyime Irrigation Project, GIDA, is under grid-tied solar system (hybrid of solar and grid), where farmers are able to save 60-70% monthly.

- *David Tuakly (REAG)* emphasized on marketing research to be done before farmers go into production of certain crops.
- *Wepia Adugwala (PFAG)* spoke about the difficulty Okyereko Irrigation Scheme farmers face in pumping water at high electricity cost from the Ayensu River into a dam that does not fill up during the rainy season. *Ebenezer Kwami (GIDA, Okyereko)* agreed with him and said the farmers currently pay averagely GH₵60,000 to GH₵70,000 per cropping season. The situation is aggravated each time the protective dyke is broken and much of the field gets flooded.
- On a GiZ incentive programme mentioned by *Bright Asante (GIDA)*, Anthony asked if such a system was still being rolled out since the Green People's Energy Project, under which it was implemented, ended. Bright answered that there is the possibility for the programme to be continued as the GiZ had contacted the solar companies that were awarded contracts to find customers for assessment.
- On a question from *Francis Akpaloo (GSA)* about who installs the SPIS system after being acquired by the farmer, and also who maintains or replaces the system if damaged, Rushabh and Eric explained that the type of equipment to be provided would be covered with warranties/guarantees not less than 10 years.
- *David Amoah (FONG)* wanted to know, particularly from representatives of the banks, if investors would be attracted to take up the "renting" business, considering a CAPEX of about US$11,200 before profit. Representatives from all the banks, including Ecobank Ghana, ARB Apex Bank and Ghana Association of Banks, agreed they would support investors and farmers under such a business model if rolled out. The banks, however, would look at the associated risks and existing business operating records or bookkeeping of the farmer.
- Looking at the project model for discussion, with an objective and a target, *Gordon Dery (ARB Apex Bank)* agreed the possibility of 15% interest rate as some projects to beneficiaries even got below 15%, but with the accompanying details and components also taken on board.
- *Larry Marcus (CAG)* raised the issue of project sustainability, and Gordon's response was that sustainability should be factored into project design; this includes capacity building of the banks to manage the risks associated specifically with the project which may differ from other risks, and also development of the farmer to a level for reduction in his risks.
- Asked by Eric to explain the opportunities available to farmers at GIRSAL (Ghana Incentive-Based Risk Sharing System for Agricultural Lending), Gordon intimated that though ARB Apex Bank relates with GIRSAL, farmers must know that as they wish to derisk through insurance and guarantees these products also come at a cost.
- *Francis Akpaloo (GSA)* emphasised on the lending institutions to do more by putting in place mechanisms to monitor the lendees, so as to facilitate loan recovery.
- *Mawuli Sevor (MOFA)* asked if insurance cost could be included in the model to help derisk some of the risks being mentioned. Imran responded that it would be possible to be accommodated as an OPEX expense.
- Anthony asked if a CAPEX of US$11,200 which was being modelled could meet any of the bank's financial envelope or threshold for lending. Gordon said yes, the amount was within funding limits, but it would be proper structuring of the loan that would be important. He also mentioned group-lending which a group of farmers could outsource.
- *Esaaba Boafo-Adjei (RDF)* also supported the group-lending approach, and added to know if the model would work for closely grouped/located farms or scattered farms or both. Imran responded by saying that practically present farmers already depended on each other, and it would be advisable for farmers to cluster and own the facilities. Any

farmer farther apart could also benefit provided the facilities to extend the services would not be too expensive.

- Sharing his experience on the proposed business cases, *Gordon Dery (ARB Apex Bank)* once met a group of farmers who were cropping under rainfed agriculture and received credit, but the group members went their separate ways after the farming season. If share-owned systems could be introduced in such areas, a good business case could be made for the financial institutions already financing such activities.
- *David Amoah (FONG)*'s comment on the business cases was that in case 1 there should be transparency, in case 2 no selfishness, and in case 3 mutual trust.
- *Larry Marcus (CAG)* gave two examples of existing farming groups (Gomoa Buduata farming with water from a dam, in the Central Region, and Anloga-Keta area, in the Volta Region) that could gain from all three models; especially the community ownership and operator ownership models, if implemented.
- *Wepia Adugwala (PFAG)* added that any facility intended for a group should ensure that capacity building formed part of the implementation, since it was observed that inexperienced groups never manage facilities well.
- There was general consensus that the description "Community Ownership" should be looked at again as past experiences had given false impressions to group members about ownership of an implemented facility.
- Oliver asked if there were any regulatory obstacles currently in place that would prevent the joint ownership models being suggested, and the response was that there was none, though the banks would be interested in the structure of the ownership.

APPENDICES

APPENDIX A – LIST OF WORKSHOP ATTENDEES

APPENDIX B – PRESENTATIONS

APPENDIX C – PHOTOGRAPHS

APPENDIX A – LIST OF WORKSHOP ATTENDEES

List of Attendees – 2023 04 13 Stakeholder Workshop

S/N	STAKEHOLDER		CONTACT DETAILS		ATTENDANCE OPTION	SEX
	Stakeholder Name	Contact Person	Mobile No.	Email Address		
1	Climate Technology Centre and Network (CTCN)	Sharone Molly		sharone.molly@un.org	VIRTUAL	Female
2		Rajiv Garg		gargr@un.org	VIRTUAL	
3	Environmental Protection Agency (EPA)	Dr. Antwi-Boasiako Amoah	050 130 1477	antwi.boasiakoamoah@epa.gov.gh	PHYSICAL	Male
4		Joseph Baffoe	050 130 1478	jabaffoe@gmail.com	VIRTUAL	Male
5	UNEP / EPA	Thomas Kankam Adjei	050 137 4744	kankamthomas@gmail.com	PHYSICAL	Male
6	Ghana Irrigation Development Authority (GIDA)	Prosper Glitse	020 378 3444	prosper.glitse@gida.gov.gh	PHYSICAL	Male
7		Mavis Acheampong	024 944 1114	maysamabakah@gmail.com	PHYSICAL	Female
8	Ghana Standards Authority (GSA)	Ing. Francis Akpaloo	020 884 0565	francis.akpaloo@gsa.gov.gh	VIRTUAL	Male
9	Peasant Farmers Association of Ghana (PFAG)	Wepia Awal Adugwala	024 226 5313	wapiaawal@yahoo.com	PHYSICAL	Male
10	Women in Agriculture Platform (WIAP)	Gilberta Akuka	024 629 7965	gilbertaakuka@gmail.com	PHYSICAL	Female
11	Agricultural Development Bank (ADB)	Kwame Asiedu Attrams	024 428 1927	kattrams@agricbank.com	VIRTUAL	Male
12		Eddie Babaloloa	026 933 0738	ebabalola@agricbank.com	PHYSICAL	Male
13	ARB Apex Bank	Gordon Dery	020 022 2564	gdery@arbapexbank.com	PHYSICAL	Male
14	University of Energy and Natural Resources (UENR)	Ing. Prof. Eric Ofosu Antwi	020 881 2106	ericofosuantwi@gmail.com	PHYSICAL	Male
15	ECOBANK Ghana	Getrude Ampofo-Tawiah	024 467 8145	gampofoh-tawiah@ecobank.com	PHYSICAL	Female
16	RDF Ghana	Angela Klufio		aklufio@rdfghana.com	PHYSICAL	Female
17	FONG (Farmer's Organization Network of Ghana)	King-David Amoah	024 386 3567	kdkamoah@yahoo.com	PHYSICAL	Male

S/N	STAKEHOLDER		CONTACT DETAILS		ATTENDANCE OPTION	SEX
	Stakeholder Name	Contact Person	Mobile No.	Email Address		
18	Ministry of Environment, Science, Technology and Innovation (MESTI)	Isaac Dakurah		isaac.dakurah@mesti.gov.gh	PHYSICAL	Male
19	GRUNDFOS	Roland Akame Elongue	055 968 9424	rakame@grundfos.com	PHYSICAL	Male
20	REAG(Renewable Energy Association of Ghana)	Enoch Yeboah Agyepong	024 498 1590	eyagyepong@gmail.com	PHYSICAL	Male
21	Energy Commission	Julius Nkansah-Nyarkoh	054 699 5989	jnkansah-nyarkoh@energycom.gov.gh	PHYSICAL	Male
22	Dream Renewables	Samuel Yeboah	050 882 6784	el.samuelyeboah@gmail.com	PHYSICAL	Male
23	Farm Radio International	Aaron Lenseini Mahamah	024 837 9903	amahamah@farmradio.org	PHYSICAL	Female
24	Dizengoff Ghana Limited	Samuel Abbey	024 214 4821	samuel.abbey@dwagh.com	PHYSICAL	Male
25		Paul Asiedu		paulvoe@gmail.com	PHYSICAL	Male
26	University of Ghana (Climate Change Centre)	Eric Nordjo	054 305 1966	enordjo@st.ug.edu.gh	PHYSICAL	Male
27	SNV	George F. Sarpong		gsarpong@snv.com	PHYSICAL	Male
28	Ministry of Food and Agriculture (MOFA) - Crop Services Directorate	Nathanael Nii-Odai Laryea	054 633 1820	niiodailaryea@gmail.com	PHYSICAL	Male
29	United Nations Development Programme (UNDP)	Saeed Abdul Razak	055 482 5903	abdul-razak.saeed@undp.org	PHYSICAL	Male
30	Integrated Water Management (IWMI)	Dr. Olufunke Cofie	024 474 1703 054 011 3517	o.cofie@cgiar.org	VIRTUAL	Female
31	ECOBANK Ghana	Ekua Akyere Asante-Antwi	055 598 0824	eaessien@ecobank.com	VIRTUAL	Female
32	Chamber of Agribusiness Ghana (CAG)	Dr. Mensah Christian Sewordor	054 624 5325	cmensah37@gmail.com	PHYSICAL	Male
33	Ghana Irrigation Development Authority (GIDA)	Mavis Baah-Acheamfuor	024 944 1114	maysamabakah@gmail.com	PHYSICAL	Female
34	Oyereko Irrigation Scheme - GIDA (Central Region)	Ebenezer Kwami	024 479 9997	kwami.ebenezer@gida.gov.gh	PHYSICAL	Male
35	Aveyime Irrigation Scheme - GIDA (Volta Region)	Samuel Debrah	024 293 3133	drebsee@gmail.com	PHYSICAL	Male
36	Dawhenya Irrigation Scheme - GIDA (Greater-Accra Region)	Timothy Nuwordu	024 440 6890	tyaws@yahoo.com	PHYSICAL	Male
37	Michel Camp Irrigation Scheme - GIDA (Greater-Accra Region)	William Sebuabe	024 365 1433		PHYSICAL	Male
38		Paul Awuvoe	024 386 4798	paulawuvoe@gmail.com	PHYSICAL	Male
39	INTEGRATION energy & environment	Mohammed Imran	+49 176 8762 8957	mimran@integration.org	VIRTUAL	Male

S/N	STAKEHOLDER		CONTACT DETAILS		ATTENDANCE OPTION	SEX
	Stakeholder Name	Contact Person	Mobile No.	Email Address		
40	INTEGRATION energy & environment	Dora Vujnovic		dvujnovic@integration.org	VIRTUAL	Female
41	INTEGRATION energy & environment	Eric Kumi Antwi-Adjei	024 456 6371	misterkumi@gmail.com	VIRTUAL	Male
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43	CARES Ghana	Anthony K.A. Kordjie	024 448 7711 050 595 0444	anthony.kordjie@cares-group.com	PHYSICAL	Male
44	CARES Ghana	Erica Imbrah	026 638 1480	erica.imbrah@cares-group.com	PHYSICAL	Female
45	CARES Ghana	Nii Ofori Tackie-Oblie	050 384 5224	nii.tackie@cares-group.com	PHYSICAL	Male

List of Attendees – 2024 04 18 Stakeholder Workshop

S/N	STAKEHOLDER		CONTACT DETAILS		ATTENDANCE OPTION	SEX
	Stakeholder Name	Contact Person	Mobile No.	Email Address		
1	Climate Technology Centre and Network (CTCN)	Sharone Molly		sharone.molly@un.org	VIRTUAL	Female
2	Environmental Protection Agency (EPA)	Joseph Baffoe	050 130 1478	jabaffoe@gmail.com	PHYSICAL	Male
3		Peggy Gbonsu	054 8731 455	queengbonsu@gmail.com	PHYSICAL	Female
4		Emmanuel Djan Adinley	055 108 9686	emmanuelashley65@gmail.com	PHYSICAL	Male
5	UNEP / EPA	Thomas Kankam Adjei	050 137 4744	kankamthomas@gmail.com	PHYSICAL	Male
6	Ghana Irrigation Development Authority (GIDA), Head Office	Prosper Glitse	020 378 3444	prosper.glitse@gida.gov.gh	PHYSICAL	Male
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S/N	STAKEHOLDER		CONTACT DETAILS		ATTENDANCE OPTION	SEX
	Stakeholder Name	Contact Person	Mobile No.	Email Address		
8	GIDA, Aveyime, V/R	Bright Kwame Asante	020 022 2564	asantebrightkwame@gmail.com	PHYSICAL	Male
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10	Ghana Standards Authority (GSA)	Ing. Francis Akpaloo	020 884 0565	francis.akpaloo@gsa.gov.gh	PHYSICAL	Male
11	Peasant Farmers Association of Ghana (PFAG)	Wepia Awal Adugwala	024 226 5313	wapiaawal@yahoo.com	PHYSICAL	Male
12	Women in Agriculture Platform (WIAP)	Gilberta Akuka	024 629 7965	gilbertaakuka@gmail.com	PHYSICAL	Female
13	ARB Apex Bank	Gordon Dery	020 022 2564	gdery@arbapexbank.com	PHYSICAL	Male
14	ECOBANK Ghana	Vivian Yeboah	024 892 0473	vyeboah@ecobank.com	PHYSICAL	Female
15	ECOBANK Ghana	Kelda Ocansey	024 535 3861	kofedie@ecobank.com	PHYSICAL	Female
16	Ghana Association of Banks	Lawrence Sackey	024 409 7255	lawrence.sackey@gab.com.gh	PHYSICAL	Male
17	RDF Ghana	Mrs. Esaaba Boafo-Adjei	024 683 1124	eboafo@rdfghana.com	PHYSICAL	Female
18	FONG (Farmer's Organization Network of Ghana)	King-David Amoah	024 386 3567	kdkamoah@yahoo.com	PHYSICAL	Male

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	Stakeholder Name	Contact Person	Mobile No.	Email Address		
19	Ministry of Food and Agriculture (MOFA) - Crop Services Directorate	Edwina Quist	055 886 9014	quistedwina@gmail.com	PHYSICAL	Female
20	Ohawu Agric College	Mawuli K.E Sevor	0240 114 630	mawulisevor@gmail.com	P HYSICAL	Male
21	REAG(Renewable Energy Association of Ghana)	Daniel D. Tuakly	0266 033 301	dtuakly@gmail.com	PHYSICAL	Male
22	Energy Commission	Kwasi Akuffo	024 970 8726	kakuffo@energycom.gov.gh	PHYSICAL	Male
23	Energy Commission	Ebenezer Ashie	055 734 9004	eashie@energycom.gov.gh	PHYSICAL	Male
24	Chamber of Agribusiness Ghana (CAG)	Larry Komi Marcus	0233 233 266	larry@syecomp.com	PHYSICAL	Male
25	Ghana Enterprises Agency	Boakye Agyeman Godfred	024 490 5248	godboah@yahoo.co.uk	PHYSICAL	Male
26	Ministry of Finance & Economic Planning (MOFEP)	Jocelyn Smith		jsmith@mofep.gov.gh	VIRTUAL	Female
27	ARB Apex Bank	James Arko	020 417 5911	jarko@arbapexbank.com	VIRTUAL	Male
28	INTEGRATION environment & energy	Mohammed Imran	+49 176 8762 8957	mimran@integration.org	VIRTUAL	Male

S/N	STAKEHOLDER		CONTACT DETAILS		ATTENDANCE OPTION	SEX
	Stakeholder Name	Contact Person	Mobile No.	Email Address		
29	INTEGRATION environment & energy	Rushabh Jain	0049-15758238922	rjain@integration.org	PHYSICAL	Male
30	INTEGRATION environment & energy	Eric Antwi-Agyei	0244 566 371	ericantwiagyei@yahoo.com	PHYSICAL	Male
31	CARES	Oliver Taylor	+44 797 778 2345	oliver.taylor@cares-group.com	VIRTUAL	Male
32	CARES Ghana	Anthony K.A. Kordjie	024 448 7711 050 595 0444	anthony.kordjie@cares-group.com	PHYSICAL	Male
33	CARES Ghana	Erica Imbrah	026 638 1480	erica.imbrah@cares-group.com	PHYSICAL	Female
34	Godfred Owusu				VIRTUAL	Male

APPENDIX B – PRESENTATIONS

Promoting Climate Adaptation by Upscaling Solar Irrigation Technology Options for Smallholder Farmers in Ghana through Innovative Financing Mechanisms, a Conductive Policy Framework for Technology Regulation and Tailored Training Modules

Stakeholder Workshop

13 April 2023

Agenda

- **Welcome/Introductions** (CTCN/NDE/CARES/INTee)
- **Project Presentation and Context** (CARES/INTee)
- **Financial Barriers to uptake of SPIS** (INTee/All)
- **Lunch** (12.30-1.30pm)
- **Risk Mitigation for Financial Institutions** (INTee/All)
- **Potential Solutions** (INTee/All)
- **AOB/Closing Remarks** (3.30pm)

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Introductions

Round table self-introduction of attendees:

- Climate Technology Centre and Network (CTCN)
- Environmental Protection Agency (EPA)
- CARES Ltd
- INTEGRATION environment & energy
- Stakeholders

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Project Aims & Objectives

To promote smallholder farmers' adaptation to climate change by providing a sustainable and efficient means of irrigation through the assessment of solar **technology options**, the design of an appropriate and sustainable **business model** for the lowest income, and the formulation of a **policy framework** for the use of Solar Powered Irrigation System (SPIS) in Ghana.

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Project Aims & Objectives

The TA is divided into four main outcomes, as follows:

- **Outcome 1**: Benchmark Solar Powered Irrigation Technologies Suitable to Smallholder Farmers in Ghana and Assess their Respective Cost-Benefits
- **Outcome 2**: Define a Business Model Targeting Smallholder Farmers for the Use of Solar Pumping Irrigation Systems in Ghana
- **Outcome 3**: National Framework on Solar Powered Irrigation Technology
- **Outcome 4**: Capacity Training to Raise Awareness on the Benefits of Solar Pumping Irrigation Systems for Smallholder Farmers in Ghana

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Methodology

Outcome 1: Benchmark Solar Powered Irrigation Technologies Suitable to Smallholder Farmers in Ghana and Assess their Respective Cost-Benefits

- Activity 1.1: Map relevant stakeholders and establish Stakeholder Working Group (SWG)
- Activity 1.2: Inception meeting
- Activity 1.3: Desk study of the agricultural and irrigation practices in Ghana
- Activity 1.4: Stakeholder workshop to introduce SPIS to Ghana´s future users, national officers, investors and private sector
- Activity 1.5: Develop a guide to SPIS technology systems appropriate for use in Ghana
- Activity 1.6: Cost analysis of the SPIS technologies and architectures.

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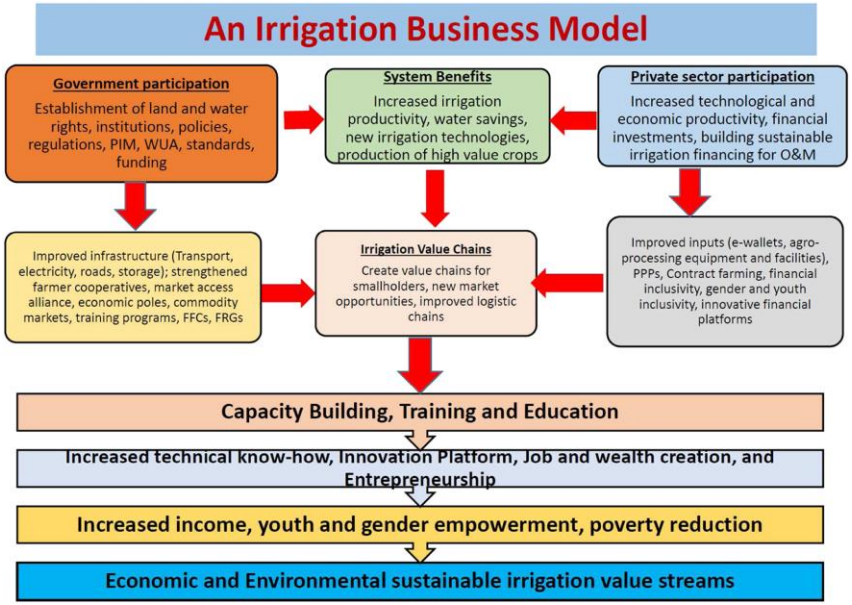
Methodology

Outcome 2: Define a Business Model Targeting Smallholder Farmers for the Use of Solar Pumping Irrigation Systems in Ghana:

- Activity 2.1: Stakeholder meeting with representatives of local smallholder farmers and financial institutions
- Activity 2.2: Define business model(s) that enable smallholder farmers to utilise SPIS
- Activity 2.3: Business model validation workshop



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Methodology

Outcome 3: National Framework on Solar Powered Irrigation Technology:

- Activity 3.1: High level governmental meeting
- Activity 3.2: Consultation with the private sector (technology suppliers and distributors)
- Activity 3.3: Draft policy framework for compliance standards and certification
- Activity 3.4: Circulate and update the policy framework from official feedback
- Activity 3.5: Official review workshop with the concerned national ministries, governing authorities and SWG
- Activity 3.6: Incorporate comments into a second draft of the policy framework
- Activity 3.7: Circulate and update the policy framework from official feedback
- Activity 3.8: Incorporate comments and finalise the policy framework.

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Methodology

Outcome 4: Capacity Training to Raise Awareness on the Benefits of Solar Pumping Irrigation Systems for Smallholder Farmers in Ghana

- Activity 4.1: Design training modules for smallholder farmers and investors
- Activity 4.2: Validate the modules through a meeting with the SWG
- Activity 4.3: Create an SPIS webpage hosted in the EPA website
- Activity 4.4: Disseminate the training modules through 3 stakeholder´s workshops (Smallholder Farmers, Private sector, EPA officers)

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Context: Agriculture and Rural Livelihoods in Ghana

- The agriculture sector employs 47% of the country's labour force, most of which are smallholder farmers, producing 80% of the country's food needs
- Agricultural productivity covers annual and perennial crops
- About 90% of farm holdings in Ghana are less than 2 hectares
- 90% of the population in semi-arid northern Ghana depend on rain-fed agriculture for their livelihoods
- Less than 20% of smallholder farmers have access to formal irrigation.




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Context: Smallholder Farming

- Agriculture in Ghana is predominantly smallholder, traditional and rain-fed with farm sizes <2ha
- Rainfall is impacted by climate change both in the north (uni-modal) and south (bi-modal)
- Smallholder farmers need assistance to switch to commercial agriculture and modern technologies for efficient use of scarce water resources, including:
  - Better infrastructure, equipment and inputs
  - Improved value chains (Storage, processing and marketing facilities).

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Context: Climate Change in Ghana

- Temperatures in Ghana are likely to increase by at least 3ºC by 2080
- The impacts will be shorter wet season, increased number of dry days, heatwaves and evapotranspiration, leading to increasing risk of droughts
- In parallel, an increase in rainfall intensity could raise the risks of flooding
- The changes will directly affect the demand and availability of water supply for agriculture, leading to decreased productivity and prolonged periods of food shortages
- The Government of Ghana has acknowledged the vulnerability of its food systems to climate impacts and prioritized the need to build resilience of farmers, especially smallholders; initiating strategies including:
  - Climate Smart Agriculture and Food Security Action Plan (CSAFSAP)
  - Climate Smart Agriculture Investment Plan (CSAIP)
  - National Climate Change Policy (NCCP).

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Context: Irrigation in Ghana

- **SUMMARY OF IRRIGATION DEVELOPMENTS IN GHANA:**

(Formal irrigation schemes)

Source: Ghana Irrigation Development Authority (GIDA)

S/N	Type of Scheme	Total Number	Total Current Irrigated Area (Ha)	Potential Area (Ha)
1.	Large-scale irrigation schemes (=>500 Ha)	6	9,378	15,087
2.	Medium-scale irrigation schemes (=>100 but <500 Ha)	26	3,298	9,925
3.	Small-scale irrigation schemes (<100 Ha)	158	3,115	6,706
	TOTAL	190	15,791	31,718

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Context: Irrigation in Ghana

Focus on the Northern and Coastal Savannah

- Problems/Constraints:
  - Farmers are unable to study the incessant changing weather conditions and rainfall pattern leading to wrong cropping time which results in poor yields, posing threat to food and nutritional security (Water Aid Ghana)
  - Large volumes of rainwater as a result of high intensity rainfall, without infrastructure to harvest, lead to flooding causing destruction to farm produce such as maize, rice, soya beans, groundnuts and vegetables, among others

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Context: Desk analysis of agricultural and irrigation practices

Soil Suitability Map for Foodcrop Production in Ghana:

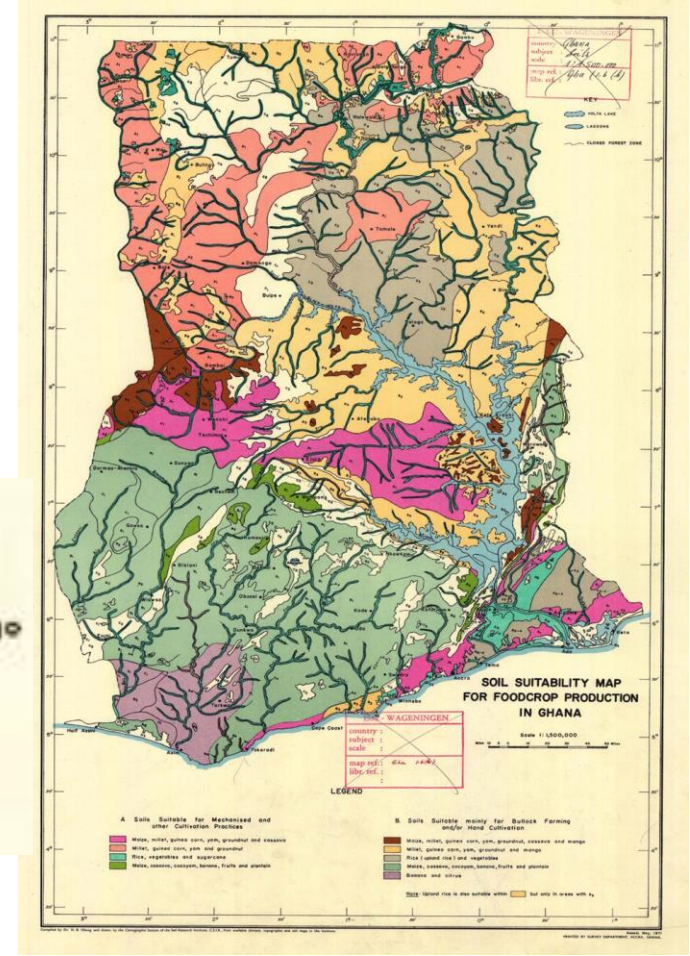
A Soils Suitable for Mechanised and other Cultivation Practices

- Maize, millet, guinea corn, yam, groundnut and cassava
- Millet, guinea corn, yam and groundnut
- Rice, vegetables and sugarcane
- Maize, cassava, cocoyam, banana, fruits and plantain

B. Soils Suitable mainly for Bullock Farming and/or Hand Cultivation

- Maize, millet, guinea corn, yam, groundnut, cassava and mango
- Millet, guinea corn, yam, groundnut and mango
- Rice (upland rice) and vegetables
- Maize, cassava, cocoyam, banana, fruits and plantain
- Banana and citrus

Note: Upland rice is also suitable within



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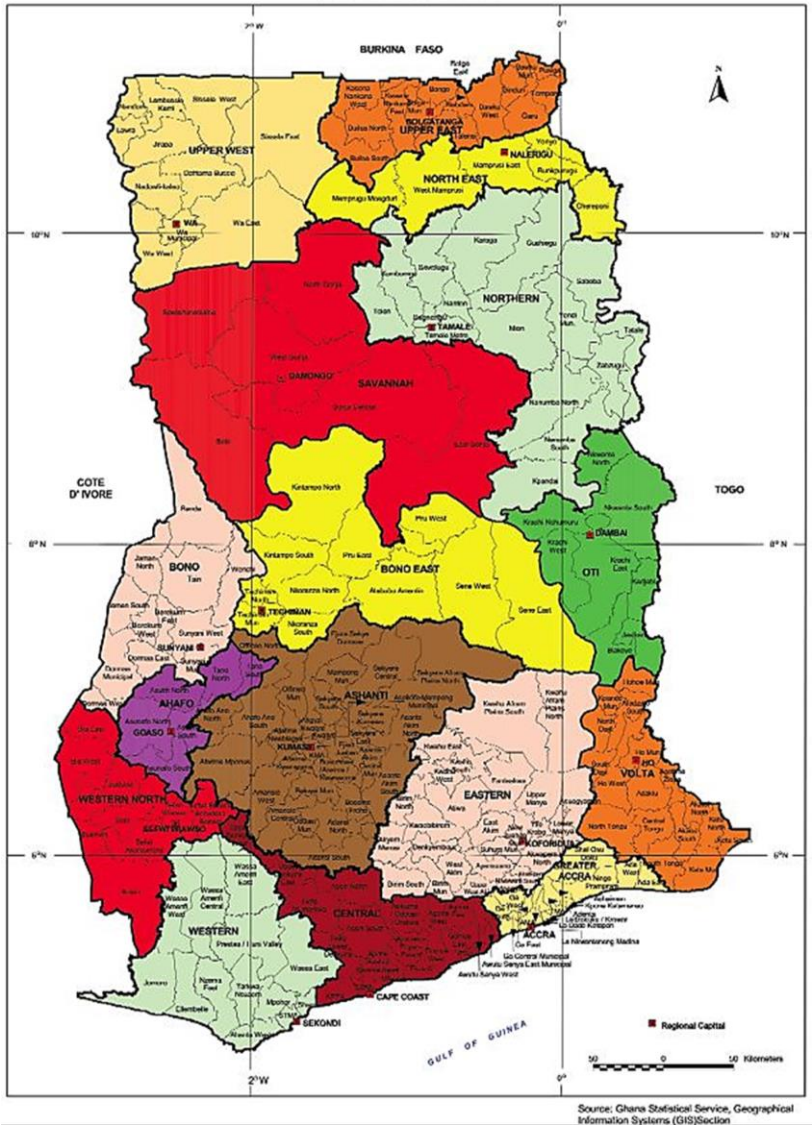
Context: Desk analysis of agricultural and irrigation practices

Water Resources for farming include:

- **Rainfall/runoff**
- **River/Stream**
- **Dam/Dugout**
- **Groundwater**



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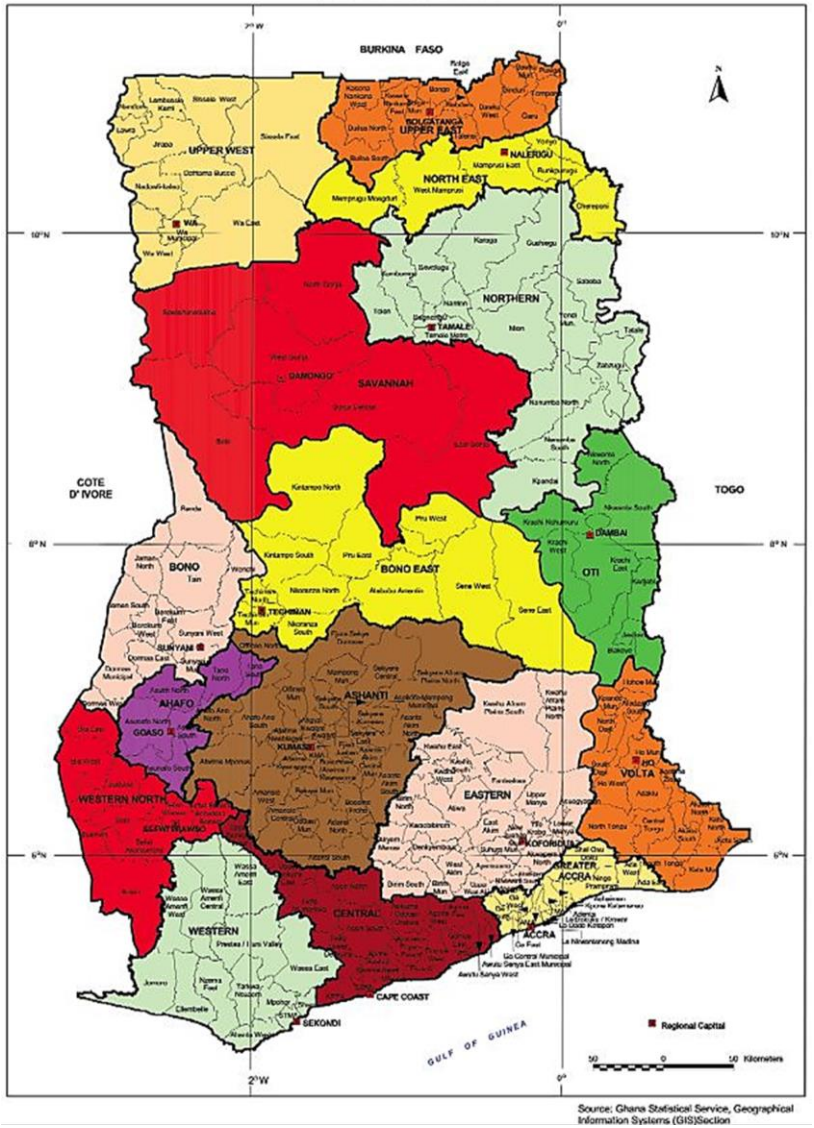
Context: Desk analysis of agricultural and irrigation practices

Crop production in Ghana generally depends on direct rainfall and its resulting runoff

- **Rainfed agriculture accounts for a large percentage of the total crop production especially rural areas in Ghana. For instance, cocoa production which contributes a substantial amount to the Gross Domestic Product (GDP) of Ghana is almost entirely dependent on rainfall, and it is therefore grown in forest areas with high rainfall**



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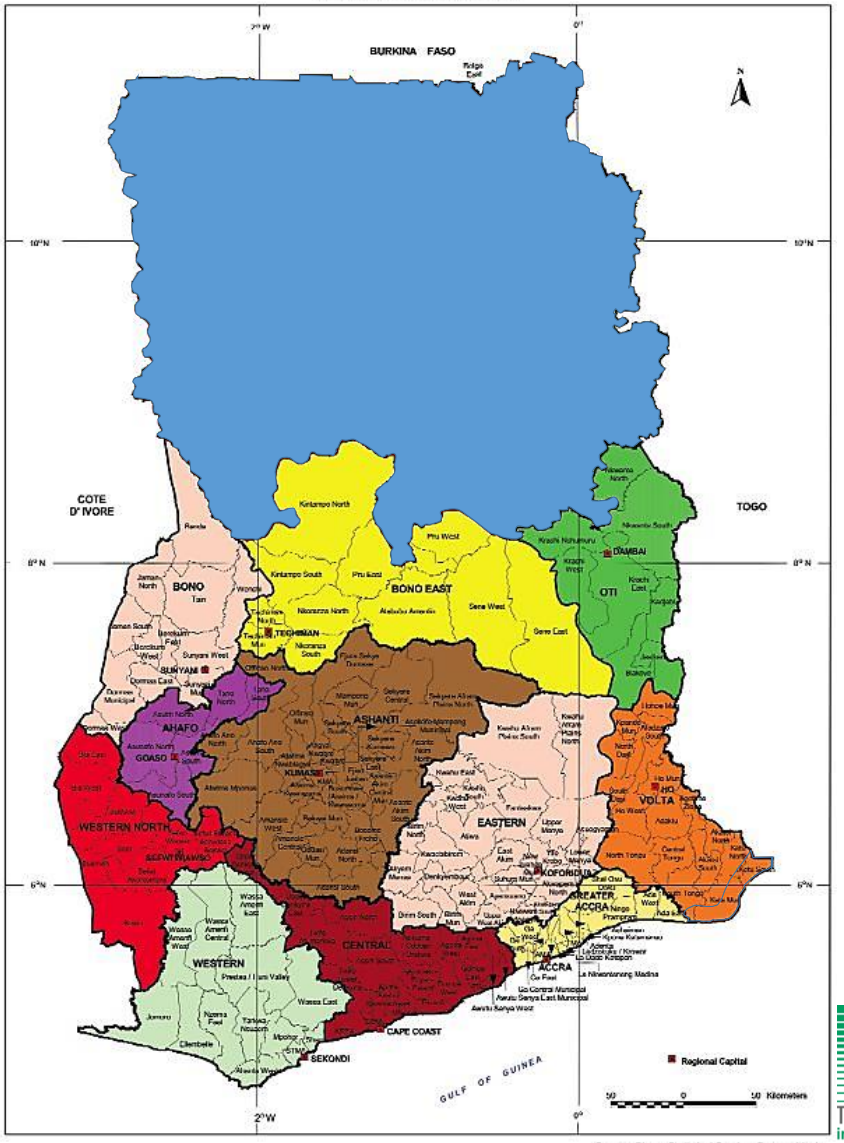
Context: Desk analysis of agricultural and irrigation practices

Northern Ghana (shaded blue), including 5 Regions – Upper East, Upper West, North East, Savannah and Northern; mainly depend on gravity dams, dugouts and pumping from the White and Black Volta rivers to farm during the dry season.

Typical Earth Dam



Source: Ghana Statistical Service, Geographical Information Systems (GIS)Section

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Context: Desk analysis of agricultural and irrigation practices

Typical crops grown in Northern Ghana include:

- **Millet**
- **Guinea Corn**
- **Upland Rice**
- **Yam**
- **Groundnut**
- **Vegetables/Leafy Vegetables**

Pumping station on a river

Pumping from non-perennial river/stream

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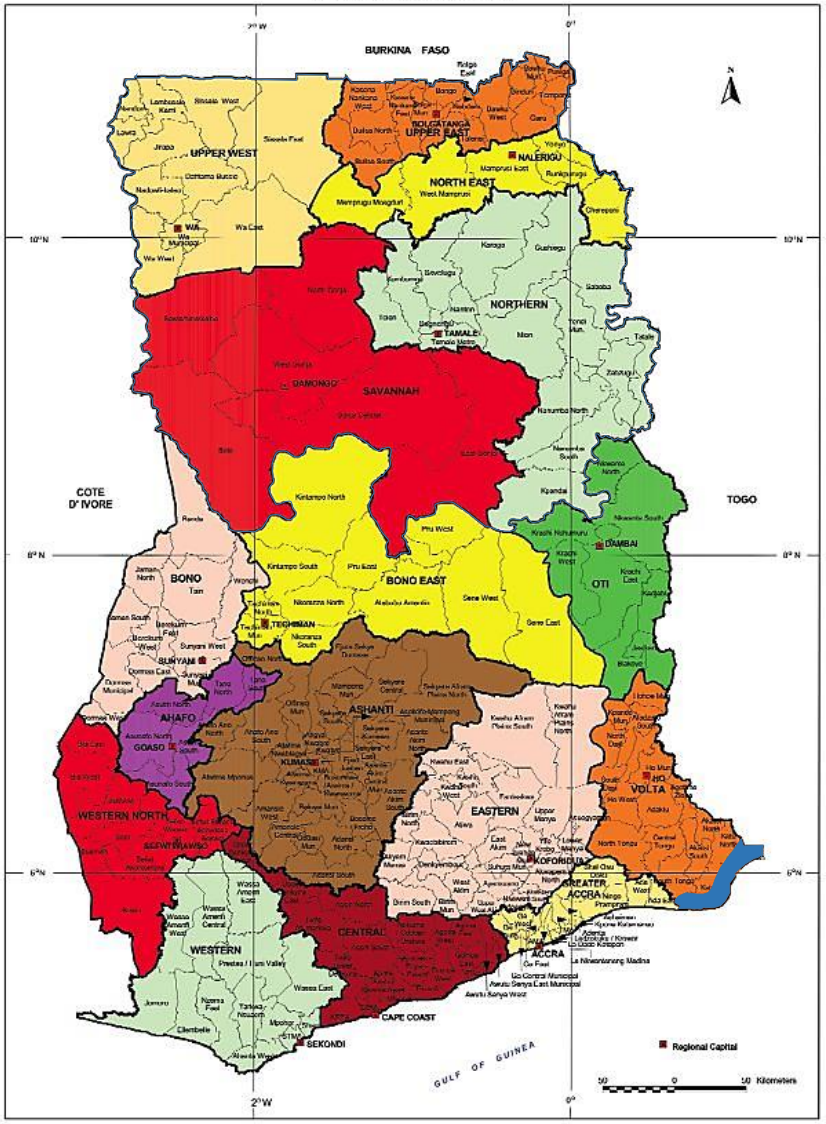
Context: Desk analysis of agricultural and irrigation practices

Another area in Ghana (shaded blue) where shallow groundwater source is typically used for farming is along the Coastal Areas of the Volta Region (VR)

Traditional irrigation system fetching water from hand-dug wells along the coastal areas of the VR



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Context: Desk analysis of agricultural and irrigation practices

Typical crops grown along the coastline of the VR include:

- **Vegetables**
- **Shallot / onion**
- **Maize**
- **Cassava**

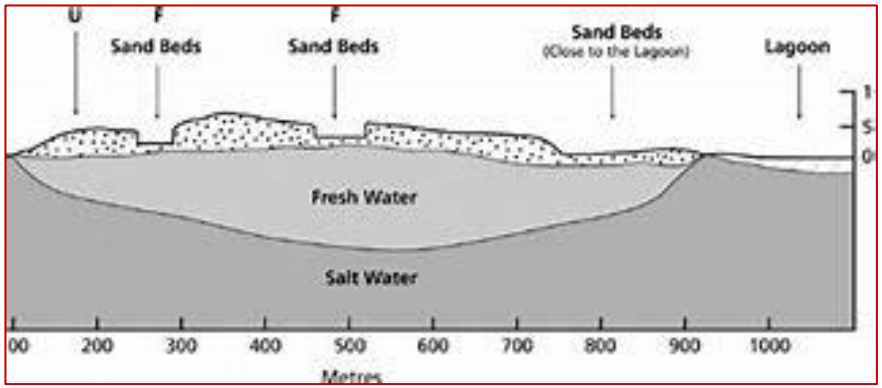

Diagram illustrating the aquifer along the VR coastline

Sprinkler irrigation using electric motor in Keta area

Typical electric pump on shallow borehole for sprinkler irrigation

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Context: Desk analysis of agricultural and irrigation practices

For dry season crop production, the Rest of Ghana (from Transition to Coastal Zones) practice irrigation by:

- **Pumping from rivers, streams, dugouts, and lakes such as Volta and Bosomtwe**
- **Water management within inland valleys found in the agro-ecological zones**
- **Gravity flow from few major dams like Kpong and Afife**

Typical inland valley water management rice cultivation system

Major crops produced include:

- **Rice**
- **Maize**
- **Cassava**
- **Plantain & Banana**
- **Tree crops such as Cocoa, Coffee, Mango, and Cashew**

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Context: Desk analysis of agricultural and irrigation practices

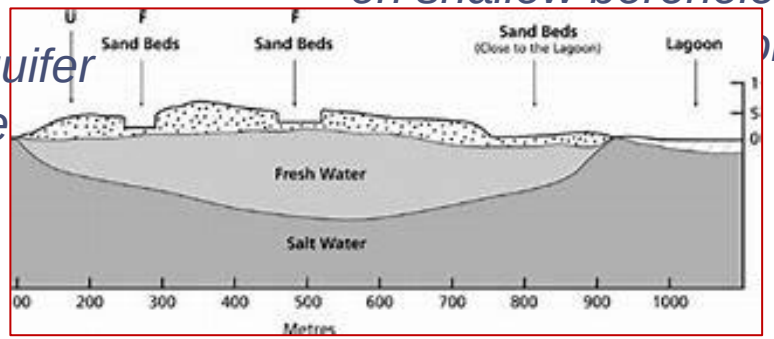
For dry season crop production, the rest of Ghana practice irrigation by:

- **Pumping from rivers, streams and dugouts**
- **Water management within inland valleys**
- **Gravity flow from few major dams**
- **Vegetables**
- **Shallot and onion**
- **Maize**
- **Cassava**

Sprinkler irrigation using electric motor in Keta area

Typical electric pump on shallow borehole

Diagram illustrating the aquifer along the VR coastline



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Identified financial challenges (from interviews and desk analysis)

- Though venture capital funding for smallholder servicing are available, their high thresholds are far above the farmer´s capacity
- Mind-set/attitude of farmers – need to be changed towards loan repayment, as it is a major setback
- Financial products and services designed for smallholder farmers are often not practical for true smallholders – banks must revise attitude of giving loans and expect short periods for repayment
- Existing structure of loans must be restructured to account for the project size and duration of the project cycle

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Identified financial challenges (from the interviews and desk analysis)

- Formation of innovative platform to discuss needs of all actors (Water, Land and Eco-systems Project, VR/Ghana)
- Gov´t / Donor Agency must own SPIS infrastructure and provide the farmers with water, and charge water-user fees
- Farmers don´t have bank accounts – must open accounts
- Farmers are unable to pay back investment capital unless during harvesting time
- Farmers´ must not see funds as government or NGO loans, but rather as personal loans

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Financing options available for smallholder farmers and existing terms and conditions (from the interviews and desk analysis)

- **Green People's Energy Project (GPEP) – funded by GIZ (Deutsche Gesellschaft fur Internationale Zusammenarbeit GmbH)**
  - Incentive/subsidy is paid to farmers under the GPEP: 40% men, 50% women
  - The ticket/project size is GH₵50,000 to GH₵80,000 per system

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SPIS Opportunities

The introduction of **Solar Powered Irrigation Systems (SPIS)**, as an adaptation intervention, addresses the water insecurity issues caused by climate change and secures benefits for productivity and profitability.

- Solar power provides reliable and affordable energy for irrigation, especially in remote rural areas where diesel fuel is expensive or there is no access to an electricity grid.
- Flexible and climate-friendly alternative energy source, with reduced CO_2 emissions
- Reducing capital costs for SPIS equipment make it a more viable adaptation option for smallholder farmers
- SPIS can also be low maintenance and have a relatively long lifespan.

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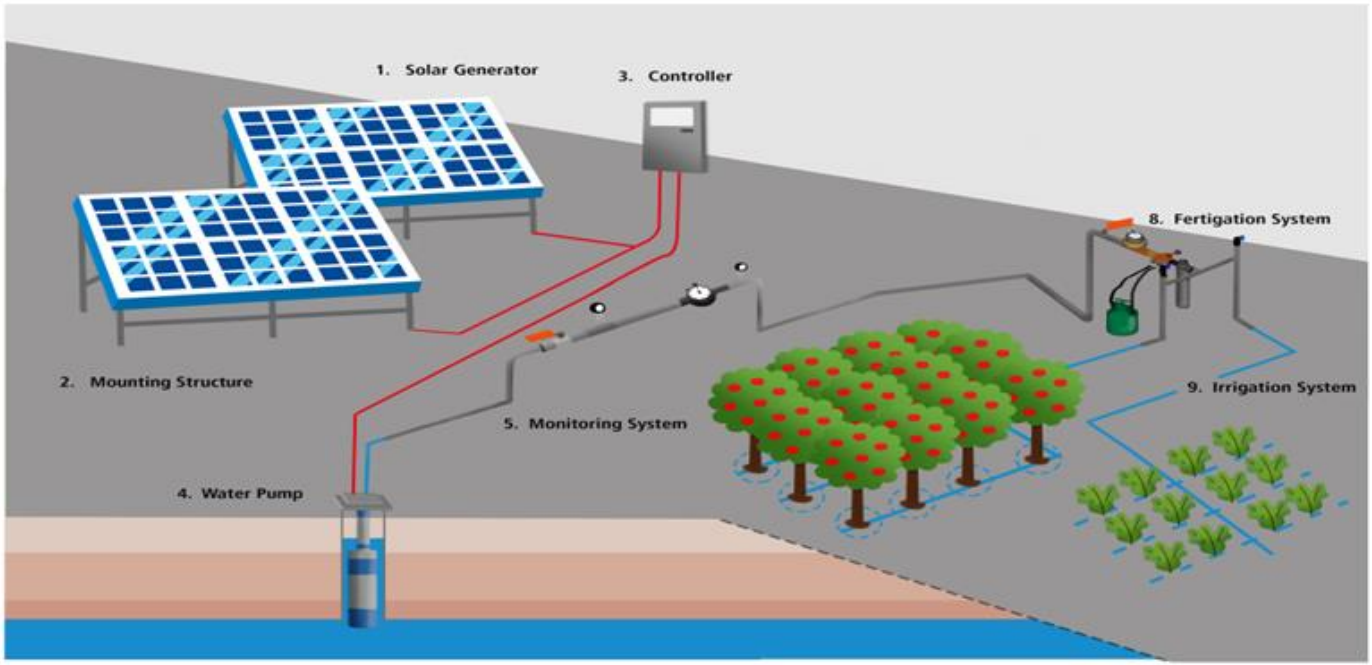
SPIS technologies

SPIS consists of key components, including the electrical photovoltaic (PV) panels, pump and controller; combined with irrigation distribution and application infrastructure.



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SPIS Constraints

Several barriers exist that constrain the uptake of SPIS by smallholder farmers in Ghana, including:

- High capital costs
- Lack of information and training on SPIS
- Few smallholder farmers have bank accounts or access to finance
- Absence of an integrated equipment supply chain and certification standards
- Insufficient enabling policies and institutional frameworks.

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Financial Barriers to Uptake of SPIS

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Financial barriers to uptake of SPIS by the smallholders

Maintenance and repair

Challenging in rural areas where access to technical expertise and fund for O&M may be limited

Lack of awareness

Often farmers are not aware of the requirements (water calculation) and benefits of SPIS (low OPEX)

Weak regulation

Insufficient enabling policies and institutional frameworks, lack of equipment standardization

Land ownership

without land ownership, investing in SPIS becomes costly if farmer must relocate after a few years

Credit worthiness of farmers

No easy system available for evaluation of credit worthiness of the farmers leading to uncertainty

High cost of finance

Economic inflation makes service debt difficult
Payback in foreign currency is more challenging

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Financial barriers to uptake of SPIS by the smallholders

Maintenance and repair

- Lack of local expertise – small issues can lead to months of shutdown >> **loss of revenues**
- Absence of O&M and spare parts supply chains in remote regions
- Lack of finance for OPEX – farmers not sensitized to saving adequate money for O&M expenses >> **need for additional loans for repairs and maintenance**

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Financial barriers to uptake of SPIS by the smallholders

Lack of awareness

- Lack of adequate know-how in estimating water demand from solar based pumps >> **oversized systems leading to unused capacity**
- Smallholder farmers are often not aware of the benefits SPIS (e.g., reduced fuel costs, improved water availability)
- Nonfamiliarity with new modes of payment (technology as well as interval of installments) >> **need for mindset change from generational ownership to loan repayment**

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Financial barriers to uptake of SPIS by the smallholders

Weak regulation

- Solar industry is still relatively new and lacks standardized financing mechanisms
- Difficult for banks to evaluate the viability of small solar projects and to develop specific financing products
- Higher transaction costs as banks have to develop new processes and procedures for each new project they finance

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Financial barriers to uptake of SPIS by the smallholders

Land ownership

- Many smallholder farmers do not own the land >> **no incentive to invest in SPIS as they may move places in a few years**
- Indivdual farms are small for owning larger efficient pumps
- Social barriers to pooling resources and financing a single large pump across multiple farms (issues with land usage, water availability, etc.)

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Financial barriers to uptake of SPIS by the smallholders

Credit worthiness of farmers

- Small size of many SPIS projects (1-2 kW) makes it difficult to conduct a thorough risk assessment, especially if the borrow is not well-established or have limited financial history
- Lack of robust and consistent evaluation criteria inline with the realities of smallholder farmers

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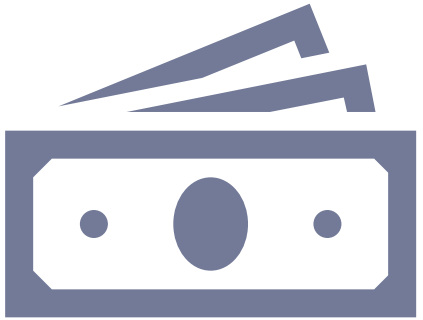
Financial barriers to uptake of SPIS by the smallholders

High cost of finance



- High prime rate from the central bank (up to 40%)
- Administrative cost of the banks (paperwork, credit checks and other due diligence activities)
- Requirement of minimum equity (approx. 20%) often unrealistic for farmers
- Financing size for small-holder farming are relatively small when compared with transaction cost for banks

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Lunch
12.30-1.30

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Risk Mitigation

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Risk mitigation for financial institutions

Adaptive business models

Improved technical requirements for systems, contractual security and flexibility of loans

SPIS vs value chain financing

Support to farmers up and down the value chain, where produce is used as security for the loan

Third party guarantees

Different types of mechanisms to secure continuous loan payments in cases of no revenue

Individual vs community level

Supporting groups of farmers lowers the risk of default, possibility for other productive uses of SPIS

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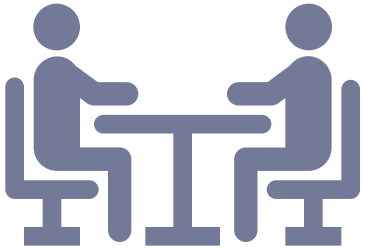
Risk mitigation for financial institutions

Adaptive business models

- Technical: stricter requirements on professional system design, installation and O&M services
- Financial: Forward contracts to provide certainty to both parties, pre-paid metering, insurances
- Loan structuring to account for project size and crop cycles >> **offer flexible / seasonal payments to coincide with crop yields**
- Water as a service (pay as you use models) >> **must be competive against services provided by diesel pumps**



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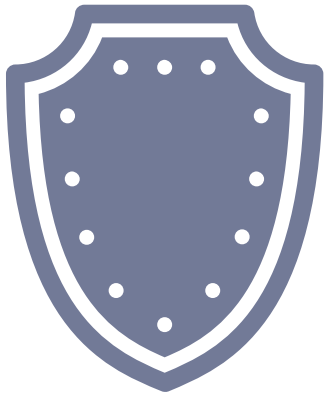
Risk mitigation for financial institutions

Third party guarantees

- Independent guarantees (e.g., WB MIGA) to reduce risk for banks
- Facilities to help farmers bridge periods / seasons of low revenue
- Need for mechanisms to de-risk the shocks of currency fluctuations
- Insurance coverage to mitigate against natural disasters (leading to bad crop yield, non-payment, etc.)



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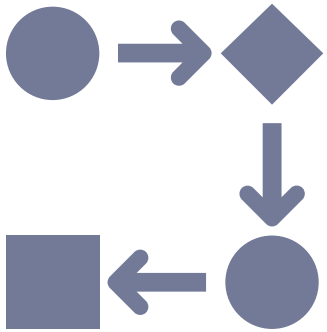
Risk mitigation for financial institutions

SPIS vs Value Chain Financing

- Supervision of farming – produce serves as security for the loan
- Partnerships with equipment suppliers and service providers to ensure farmers can maximize SPIS usage
- Supporting farmers in agro processing, value addition of products to increase revenues and earnings
- Additional financing windows for purchase of processing equipment, packaging and transport facilities
- Linking farmers with market players to guarantee off take of produce
- **Agricultural Development Bank (ADB) successfully implementing first pilot projects**



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Risk mitigation for financial institutions

Individual vs Community level financing

- Partnering with local cooperatives, associations and community committees to finance pool of farmers collectively instead of individual loans
- Community, grass root level organizations better suited to ensure recovery of loans (community level efforts for loan repayment and mutual support)
- Higher likelyhood of community jointly raising equity contribution
- Larger, more efficient pumping systems, excess capacity for other productive uses
- **Village Savings and Loan Association (VSLA) system implemented by Rural Development Fund (RDF)**

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Potential Solutions

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Potential solutions

Development of portfolios

Identification of areas suitable for SPIS and standardization of systems per region

Productive use

SPIS is used to improve revenue streams and ensure loan payments by other applications

Capacity building

Training on technical and financial aspects od SPIS and a platform to access information

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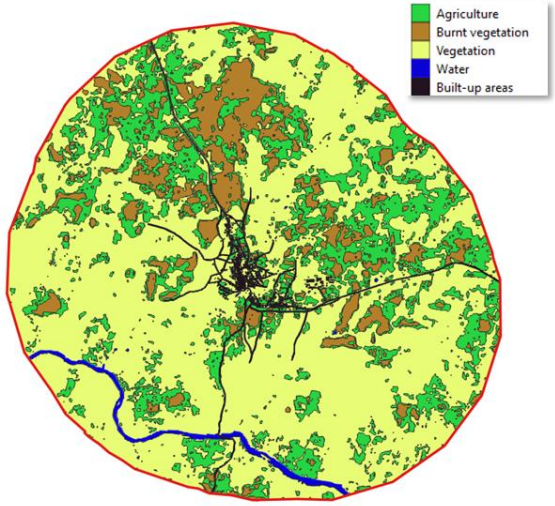
Potential solutions

Development of portfolios

- Use of multiple data sources for identification of suitable location suited for SPIS technology
- Standardization of system designs based on geographic regions of Ghana:
  - Northern Ghana (Savannah region – surface pumping)
  - Southern Ghana (Costal region – ground water pumping)
- Creation of project portfolios / clusters bases on geographical areas, technology options, aggro-processing value chains



Potential overlap with IWMI irrigated area dataset

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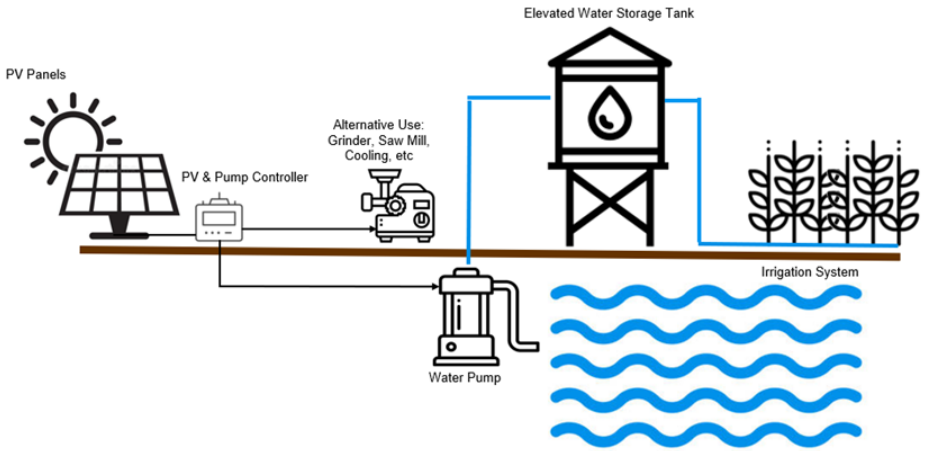
Potential solutions

Productive use and other income generating activities

- Incremental increase in solar capacity if often not cost prohibitive
- Potential for coupling other productive use applications, e.g.:
  - Milling when pump is not in used
  - Cooling or drying

- Provides value addition to farmer and improves revenue streams to pay back loans
- Promotes local entrepreneurship, new businesses



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Potential solutions

Local capacity building

- Trainings and awareness raising campaigns for farmers
- Trainings for local electricians to provide services on solar panels and pumping systems as well
- Formation of cooperatives and farmer groups
- Promotion of local groups to jointly raise financing, funds and connect with market players for value chain benefits
- Platforms to enable smallholder farmers to get access to information, interact with stakeholders and actively participate in development of the sector (instead of just being on the receiving end of the process)

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Updates 09.01.2024

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Revised Target KPIs (Key Performance Indicators)

Payback period	< 8 years
Equity Return on Investment	> 15 %
Min. DSCR	1.0

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CAPEX

Specifications		Old Price (USD)	Price %
Pump	Surface Pump (0.6 kW)	3,000	18%
Solar PV	1.1 kW	1,700	10%
Storage System	4 x 10,000 litre elevated tank	6,000	35%
Irrigation Network	Drip Irrigation, 1 ha	3,500	21%
Balance of System	Transport, civil works, fencing	2,800	16%
Total		**17,000**	**100%**

Specifications		Revised Price (USD)	Price %
Pump	Surface Pump (0.7 kW)	3,000	26%
Solar PV	1.1 kW	1,500	13%
Storage System	10,000 litre elevated tank	1,300	11%
Irrigation Network	Drip Irrigation, 1 ha	3,000	26%
Balance of System	Transport, civil works, fencing	2,700	24%
Total		**11,500**	**100%**

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OPEX

Farm Size (ha)	1 operator	1 tariff collector	1 Management	1 Security
1 ha	0%	0%	0%	10%
5 ha	10%	0%	0%	20%
10 ha	25%	0%	0%	25%
15 ha	25%	25%	0%	25%
20 ha	25%	25%	25%	25%

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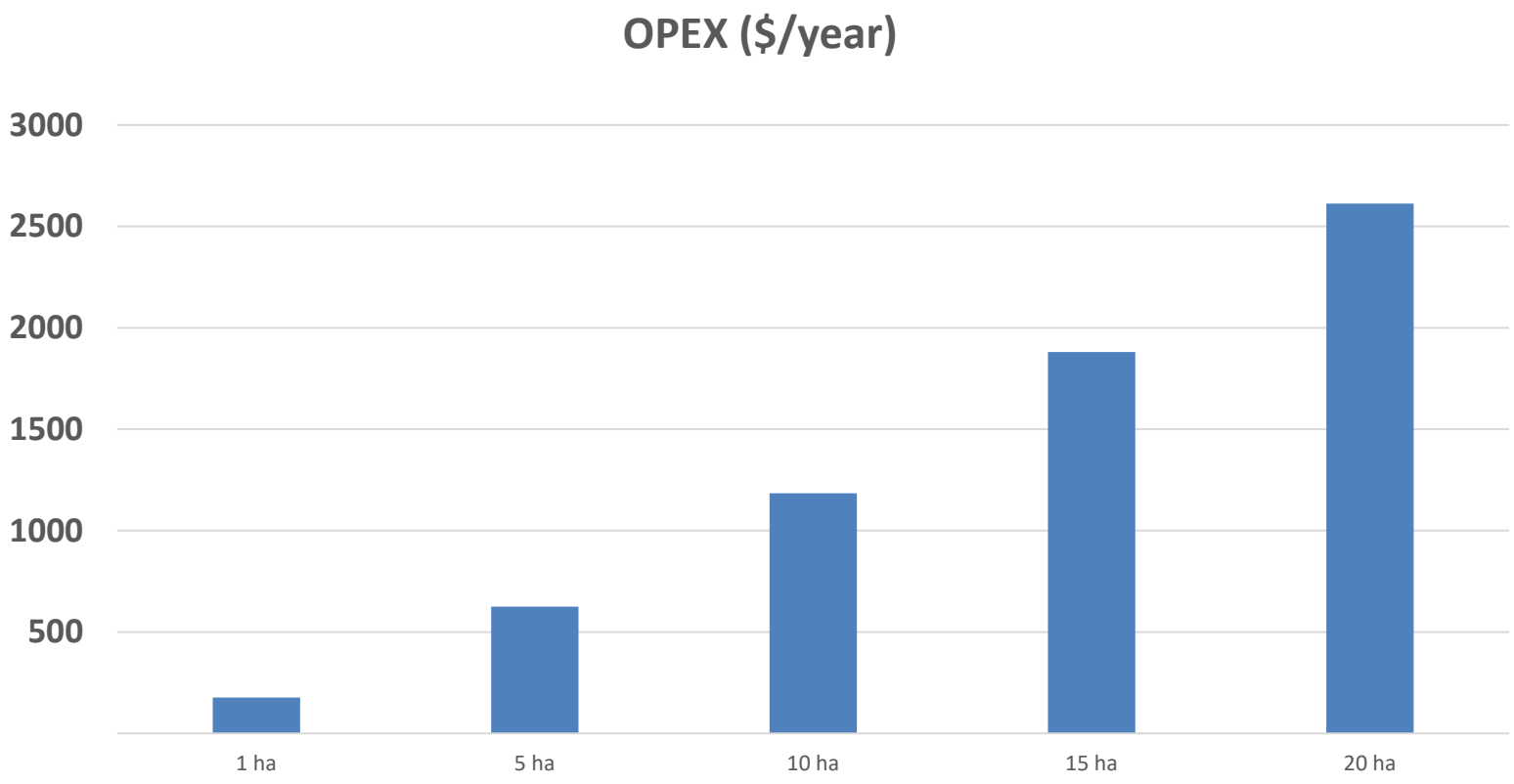
OPEX



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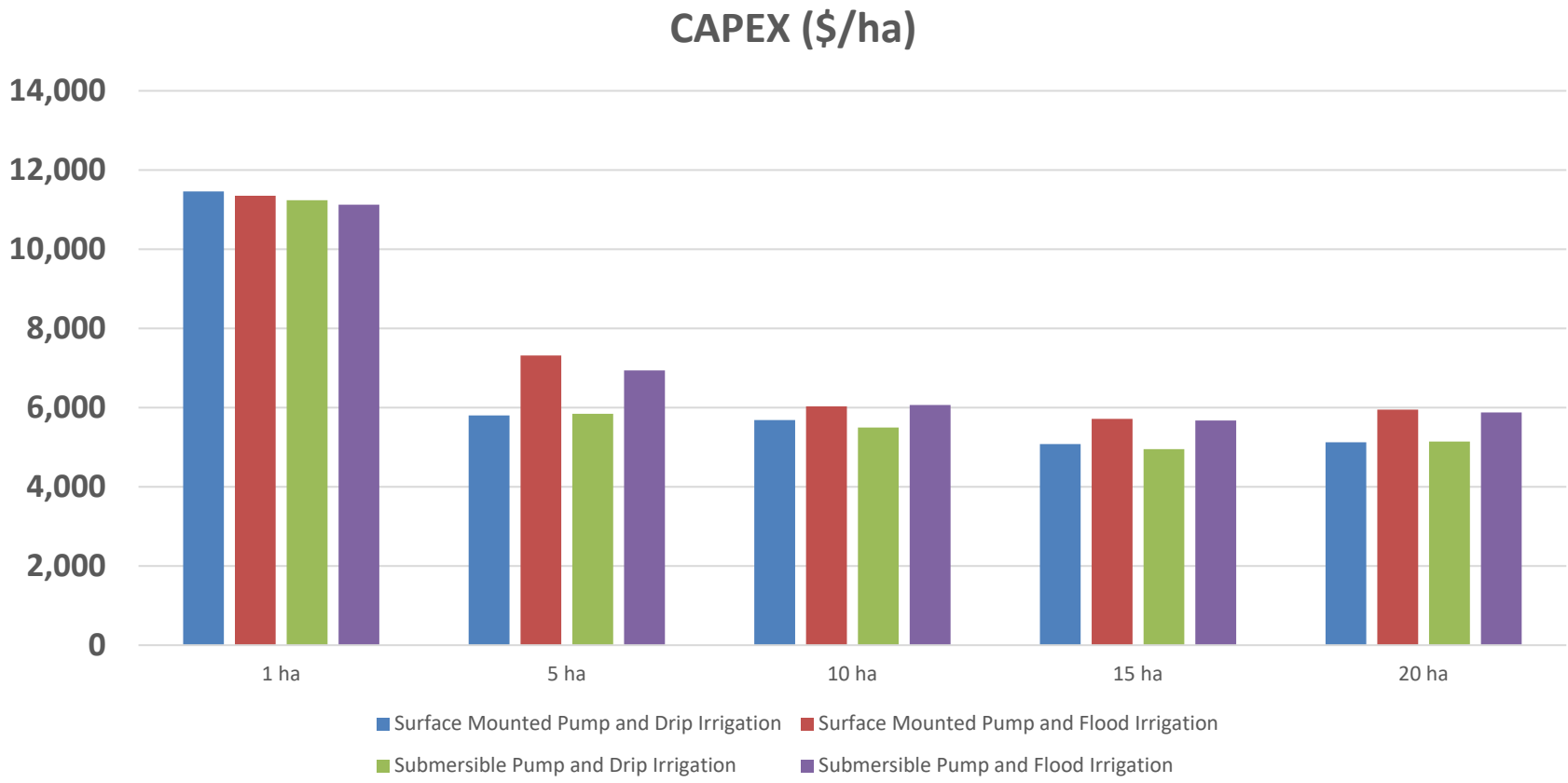
CAPEX



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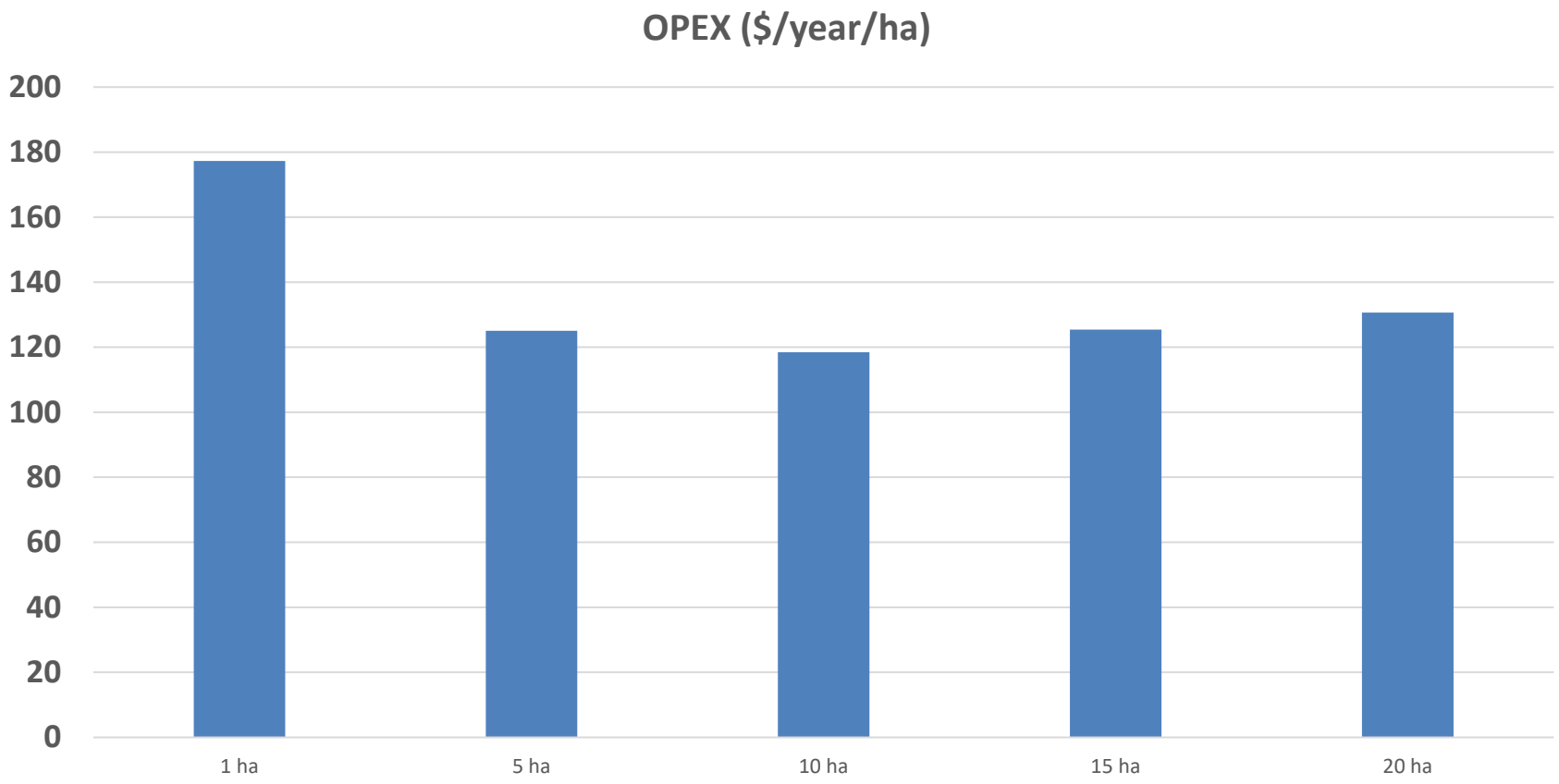
OPEX



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Tariff Scenarios
(Operator Perspective)

- *Approach A:*
  Calculation of financial KPIs for fixed tariff levels

- *Approach B:*
  Calculation of Tariff for desired financial KPIs

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Initial Modelling Results

Approach A:
Find KPIs for different fixed tariffs

System Size		1 ha				5 ha			10 ha			15 ha			20 ha		
Tariff		Base tariff	Tariff hike 1	Tarif hike 2	Tarif hike 3	Base tariff	Tariff hike 1	Tarif hike 2	Base tariff	Tariff hike 1	Tarif hike 2	Base tariff	Tariff hike 1	Tarif hike 2	Base tariff	Tariff hike 1	Tarif hike 2
		105	150	200	350	105	150	200	105	150	200	105	150	200	105	150	200
Base Case	30% Rate,15%VAT	0.00%	-27.60%	-17.37%	2.43%	-20.64%	-7.64%	4.53%	-19.37%	-6.42%	5.89%	-18.08%	-4.04%	9.54%	-19.01%	-4.89%	8.62%
Low Interest	15% Rate,15%VAT	-30.61%	-21.76%	-12.01%	10.44%	-15.61%	-1.10%	12.87%	-14.21%	0.28%	14.46%	-12.79%	2.99%	18.72%	-13.82%	2.03%	17.65%
Low Interest & Low Tax	15% Rate,0%VAT	-29.43%	-16.28%	-6.20%	18.98%	-9.20%	6.41%	22.51%	0.00%	7.88%	24.32%	-5.89%	11.38%	29.81%	-6.86%	10.37%	28.62%

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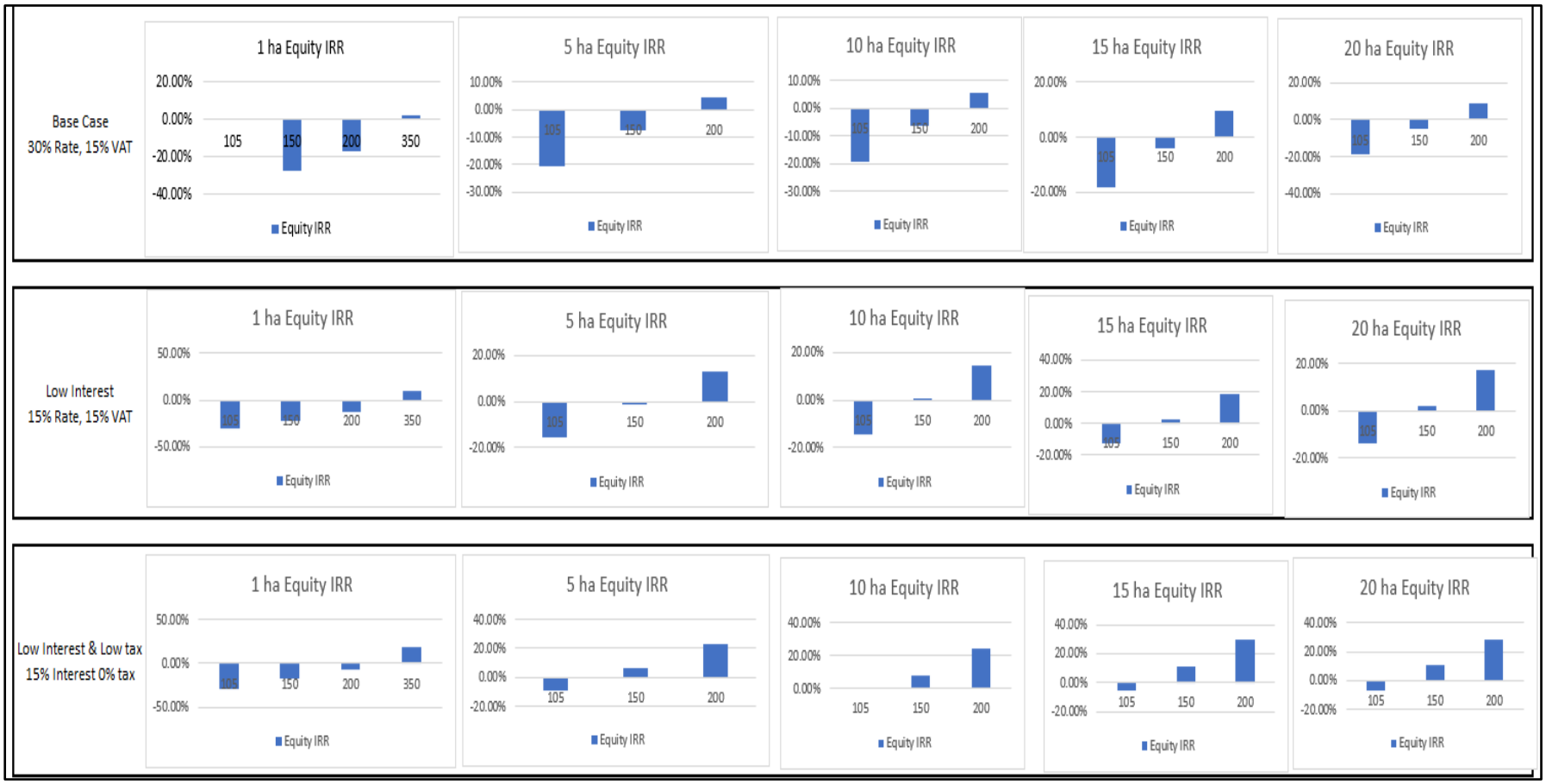
Initial Modelling Results (Approach A)



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Approach B:

Find tariff to meet KPIs (15% equity IRR, 8 years payback)

Flood Irrigation

System Size		1 ha	5 ha	10 ha	15 ha	20 ha
Base Case	30% Rate,15%VAT	452	299	251	243	253
Low Interest	15% Rate,15%VAT	380	252	212	207	216
Low Interest & Low Tax	15% Rate,0%VAT	323	214	180	176	183

Drip Irrigation (replacement of irrigation channels every 18 months)

System Size		1 ha	5 ha	10 ha	15 ha	20 ha
Base Case	30% Rate,15%VAT	776	550	544	526	530
Low Interest	15% Rate,15%VAT	703	513	508	494	497
Low Interest & Low Tax	15% Rate,0%VAT	598	436	431	420	423

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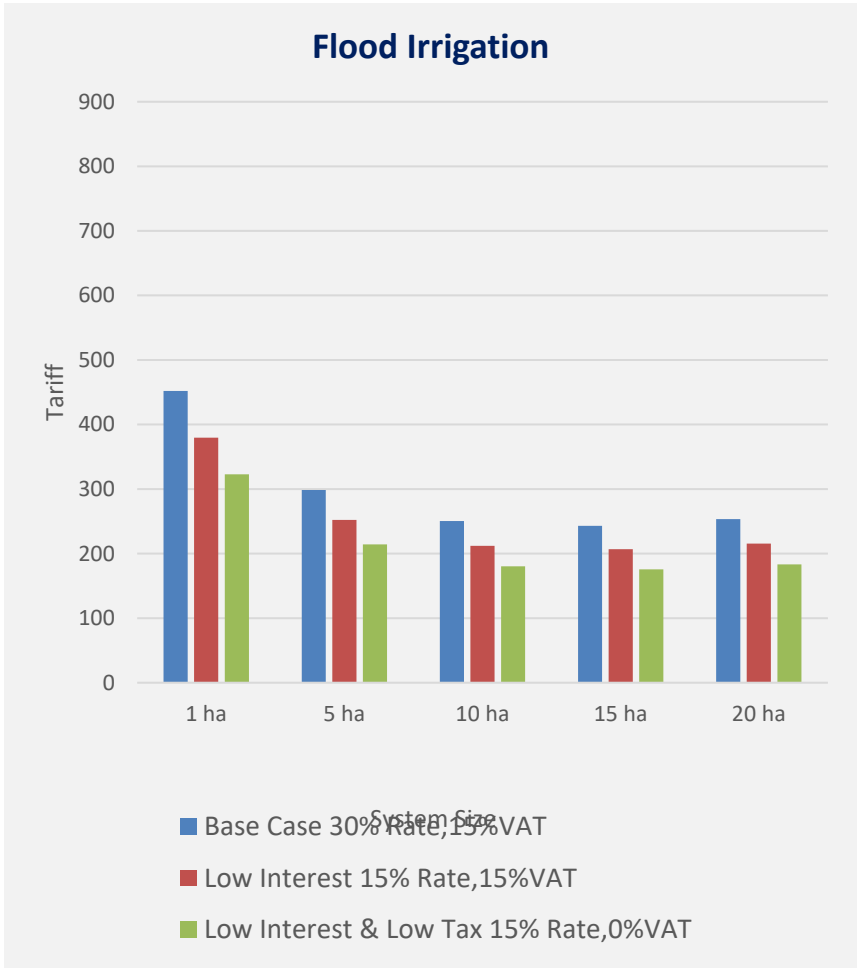
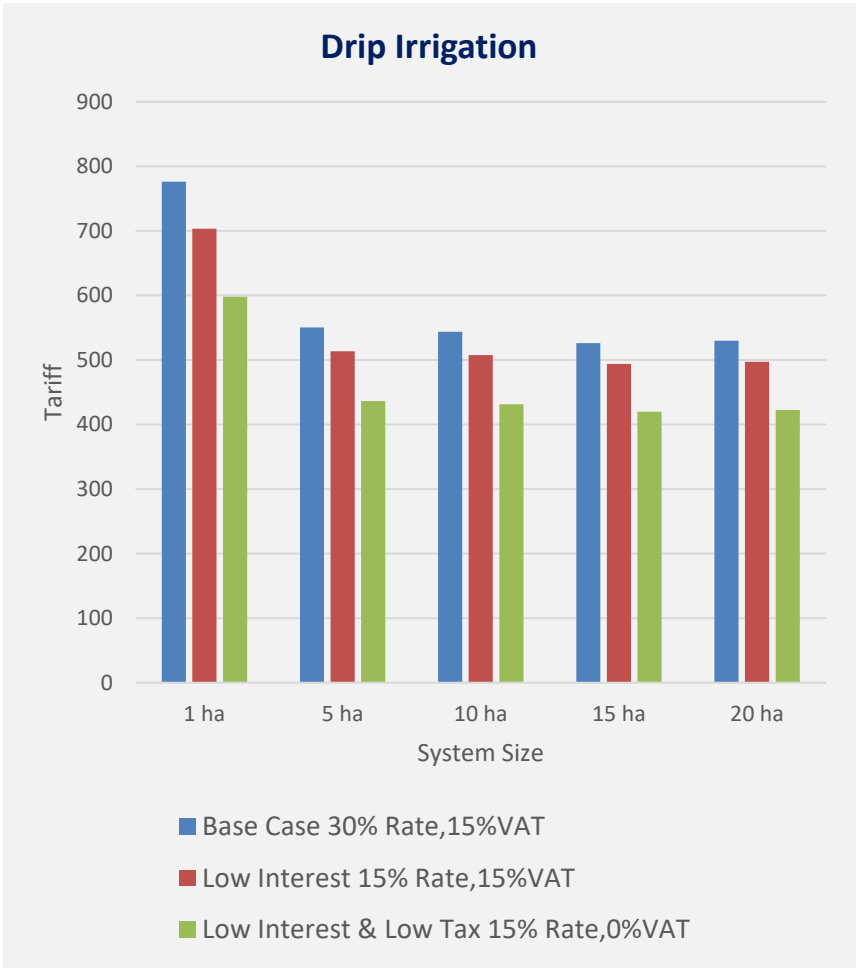
Initial Modelling Results (Approach B)





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Production Scenarios (Farmer Perspective)

Northern Savannah												
Month		January	February	March	April	May	June	July	August	Septemb	October	Novembe	Decembe
Season		Dry							Wet			Dry	
		Crop											
Soils	Good	3rd Crop: LETTUCE				1st Crop: CABBAGE				2nd Crop: TOMATO			
	Marginal	3rd Crop: TOMATO				1st Crop: LETTUCE				2nd Crop: EGG PLANT			
	Poor	3rd Crop: GROUNDNUT				1st Crop: GROUNDNUT				2nd Crop: COWPEA			
Perennial Crops (matured trees)		1st Crop: MANGO											

Coastal Savannah												
Month		January	February	March	April	May	June	July	August	Septemb	October	Novembe	Decembe
Season		Dry					Wet - Minor		Wet - Major			Dry	
		Crop											
Soils	Good	3rd Crop: LETTUCE				1st Crop: LETTUCE				2nd Crop: EGG PLANT			
	Marginal	3rd Crop: CARROT				1st Crop: ONION				2nd Crop: EGG PLANT			
	Poor	3rd Crop: GROUNDNUT				1st Crop: GROUNDNUT				2nd Crop: COWPEA			
Perennial Crops (matured trees)		1st Crop: PAPAYA (or AVOCADO/CITRUS/CASHEW/PINEAPPLE/MANGO)											

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Production Scenarios (Farmer Perspective)

Coastal Savannah					
Month		**May**	**June**	**July**	**August**
Season		**Dry**	**Wet - Minor**		**Wet -**
		Crop			
Soils	Marginal	*1st Crop: ONION*			
		Irrigation (litres/ha)	*Yield (tons/ha)*	*Cost of Production (US$/ha)*	*Market Selling Price*

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Programme
(Key Dates to be Confirmed)

1. **SWG Meeting** on business model(s) and defining scenarios for the perspective of smallholder farmers - **15-22nd January**
2. **Business Model Validation Workshop** (Output 2) - **Weds 31st Jan** (alt Thur 1st Feb)
3. **Stakeholder Consultation** on compliance and certification for SPIS - **Mid-February** (Government and private sector tech providers and distributors)
4. **National Policy Framework Workshop** (Output 3) - **Mid-March** (Ministries, Authorities and SWG members)
5. **Stakeholder Consultation** on capacity and training needs - **Mid April** (Education and training providers for smallholder farmers and investors)
6. **Training Dissemination Workshops** (Output 4) - **End April** (SWG, Smallholder farmer representatives, Private sector and EPA officials)

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APPENDIX C – PHOTOGRAPHS

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Recommendation on Business Cases
Community ownership model
Corporate ownership model
Shared ownership model


Thank you!


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