IRRIGATION AS A SERVICE

Trainer's Manual



Training Manual

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Acknowledgement
Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA) is a project that helps deliver a climate-smart African future driven by science and innovation in agriculture. It is led by the Alliance of Bioversity International and CIAT and supported by a grant from the International Development Association (IDA) of the World Bank. Explore our work at aiccra.cgiar.org

About AICCRA Reports
Titles in this series aim to disseminate interim research on the scaling of climate services and climate-smart agriculture in Africa, in order to stimulate feedback from the scientific community.

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ABOUT AICCRA

CGIAR | AICCRA Accelerating Impacts of CGIAR Climate Research for Africa

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ACRONYMS

AICCRA	Accelerating Impacts of CGIAR Climate Research for Africa
CSA	Climate-smart agriculture
CSV	Climate-Smart Villages
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IWMI	International Water Management Institute

INTRODUCTION

Background information

This trainer's manual provides comprehensive guidance for delivering a structured training program on Irrigation as a Service (IaaS). The manual integrates technical irrigation principles, service enterprise management, financial planning, risk mitigation, and scaling strategies. It is designed for trainers who work with youth entrepreneurs, farmer groups, and irrigation service providers.

Training Objectives

By the end of the training, participants will be able to:

- Understand irrigation as a business enterprise rather than a technical activity only.
- Identify and calculate fixed and variable costs of irrigation services.
- Compute gross margin, break-even point, and return on investment.
- Design appropriate pricing models for irrigation services.
- Develop financial calendars and manage cash flow.
- Identify production, financial, and market risks.
- Draft service contracts and maintain records.
- Prepare a basic irrigation business plan.

Who is this training manual for?

- Irrigation entrepreneurs and aspiring service providers
- Youth agribusiness service providers
- Women's groups and farmer cooperatives
- Extension officers and agribusiness incubators
- Lead farmers operating portable solar pumps.

APPROACHES AND METHODS

The training follows adult learning principles: participatory engagement, experiential learning, practical exercises, real-world simulations, and financial calculations. Trainers are encouraged to adapt examples to local contexts.

This training is designed for Irrigation entrepreneurs, Youth agribusiness service providers, Women groups, Farmer cooperatives, Extension officers, and Agribusiness incubators.

MODULE 1: TECHNICAL FOUNDATIONS OF IRRIGATION

Types of Irrigation Systems

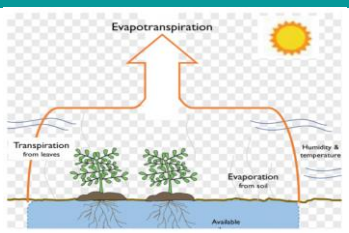
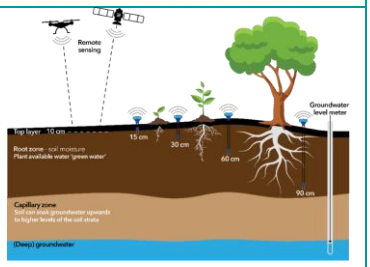
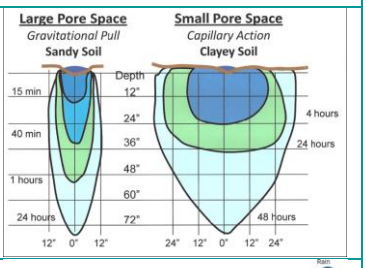
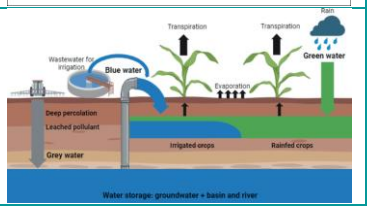
There are several types of irrigation systems suitable for smallholder farmers. Each has different costs, benefits, and suitability depending on the water source, crop type, and land size.

- Surface irrigation: Water flows by gravity along furrows or basins. Low cost but less water-efficient. Suitable for flat land.
- Sprinkler irrigation: Water is pumped through pipes and sprayed over crops. More efficient than surface irrigation. Higher initial cost.
- Drip irrigation: Water drips slowly near plant roots. Very efficient. Best for high-value vegetables. Higher cost but lower water use.
- Solar pumping systems: Use solar panels to power a pump. No fuel cost. Ideal for smallholders. The initial cost is higher, but the operating cost is very low.
- Mobile diesel or petrol pump systems: Portable and flexible. Fuel cost is a major ongoing expense. Easier to access than solar in some areas.

Crop Water Requirement Concepts

Trainers should explain evapotranspiration, soil moisture, irrigation frequency, and water-use efficiency. Use diagrams or local examples.

Table 1: Crop water requirement concepts

Concept	Description	Illustration
Evapotranspiration	Water lost through evaporation from soil and transpiration from plants. ET varies by temperature, humidity, and wind speed.	
Soil moisture	Irrigate when soil moisture falls below a threshold not too wet (waterlogging) and not too dry (stress).	
Irrigation frequency	How often you irrigate depends on crop type, soil type, and weather. Sandy soils need more frequent irrigation than clay soils.	
Water-efficiency	Delivering the right amount of water at the right time reduces waste and improves yields.	

Source: Sensoterra. (2023, October 13).https://www.sensoterra.com/news/why-should-we-measure-soil-moisture-in-the-root-zone/

Safety Protocols

Table 2: Safety protocols

Before Operation	During Operation	After Operation
Inspect all hoses and fittings for cracks or leaks	Wear rubber-soled boots and gloves at all times	Switch off pump and disconnect panels before moving
Check panel connections are dry and secure	Never stand in water while operating electrical components	Clean filter after every session
Confirm water source is clear of contamination	Do not irrigate during lightning or storms	Store pump in a dry, locked location

Ensure panels face correct direction for maximum sun	Keep children and animals away from the pump area	Record hours used in the pump log

SAFETY

- Never operate the solar pump while standing in water or during a lightning storm.
- Do not submerge the spray head of the ULVA+ or solar pump motor in water because this destroys the electric motor.
- Store all equipment in a dry, locked location when not in use to prevent theft and damage.
- Keep children and animals away from the pump area during operation.

MODULE 2: IRRIGATION AS A SERVICE ENTERPRISE MANAGEMENT & FINANCIAL CONTROL

Irrigation as a Service (IaaS) is a structured rural enterprise that transforms access to water into economic value. It requires capital, risk, cash flow, and client relationship management.

Enterprise Mindset

Successful irrigation providers move from equipment operators to enterprise managers. They sell outcomes such as yield stability and reduced climate risk, not just pumping hours.

- View irrigation as a value proposition.
- Manage solar pumps as depreciating assets.
- Prioritize cash flow timing.

Cost Structure Analysis

Table 3: Cost structure analysis

Cost Type	What it includes	IaaS Examples
Fixed Costs	Costs that stay the same regardless of how many hectares you irrigate	Pump, solar panels, tanks, piping - spread across seasons as depreciation
Variable Costs	Costs that change depending on how much service you provide	Labour, fuel/energy, transport, chemicals for water treatment
Opportunity Costs	Value of time and resources used that could have gone elsewhere	Your time managing the business; time not spent on own farming

Risk Costs	Provision for unpredictable events that cost you money	Breakdown reserve fund, non-payment risk, theft, drought impact

Pricing Strategy: Cost-Reflective and Investment-Ready Tariff Design

Pricing in IaaS is a strategic financial decision, not merely a market negotiation. Sustainable irrigation enterprises must implement pricing models that ensure full economic cost recovery, risk coverage, asset replacement, and reinvestment capacity.

A pricing structure is considered sustainable when it:

1. Covers fixed and variable costs
2. Includes depreciation of capital assets
3. Accounts for operational risk and revenue volatility
4. Generates surplus for expansion and technology upgrades
5. Maintains affordability within local market conditions

Under pricing irrigation services may temporarily increase demand but results in long-term enterprise fragility, asset deterioration, and inability to scale.

Components of Cost-Reflective Pricing

A sustainable irrigation tariff must incorporate:

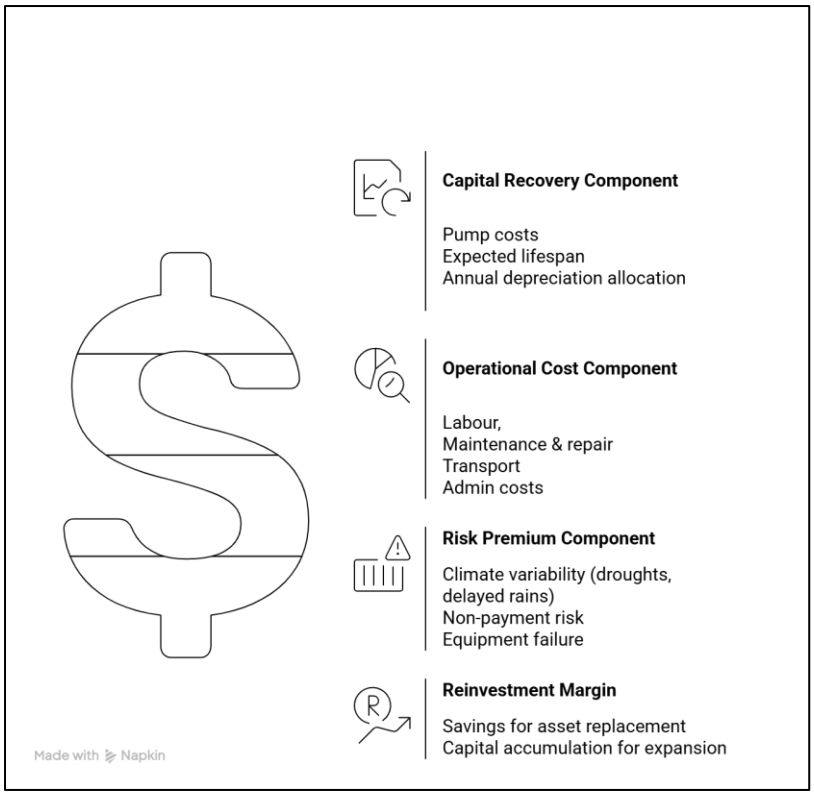


Figure 1: Components of cost-reflective pricing

Pricing Models for Irrigation Enterprises

Table 4: Pricing models for irrigation enterprises

Model	How it works	Best for
Per hectare per season	Flat fee per hectare irrigated each season	Stable client base with fixed plot sizes
Per hour of pumping	Client pays for time the pump runs	Clients with variable needs; easy to monitor
Seasonal bundled contract	Fixed total fee for the whole season	Long-term clients; predictable income for provider
Subscription-based	Monthly or fortnightly payment for guaranteed access	Vegetable farmers who irrigate year-round
Cooperative block pricing	Group of farmers share cost; provider charges group collectively	Farmer groups or cooperatives in the same area

TRAINER NOTE

- Ask participants: "Which model do you currently use?" Then ask: "Which model gives you the most predictable income?"
- The selected pricing model must align with client cash flow cycles (when farmers receive harvest payments), the crop production calendar, market access reliability, and any financing arrangements.
- Seasonal bundled contracts are recommended for most smallholder IaaS providers — they protect income even when some sessions are missed due to weather.

Facilitators should emphasize that the selected model must align with:

1. Client cash flow cycles
2. Crop production calendar
3. Market access reliability
4. Institutional financing arrangements

Break-Even and Minimum Viable Tariff

- The minimum viable price must ensure:
- Break-even hectares = Total Full Cost ÷ Price per hectare

Break-even formula:

- Break-even hectares = Total Full Cost (ZMW) ÷ Price per hectare (ZMW)
- Example: ZMW 2,000 total cost ÷ ZMW 1,800 per hectare = 1.1 hectares minimum to break even

- However, break-even is not profitability.
- For bankability and resilience, pricing must exceed break-even sufficiency to:
  1. Cover depreciation
  2. Build reserve funds
  3. Maintain positive cash flow
  4. Service potential debt

Worked Financial Exercise:

Exercise 1: IaaS worked Example (2ha)

Table 5: IaaS worked example

Item	Unit	Qty	Price (ZMW)	Total (ZMW)
1. MONEY IN (Revenue)				
Service fee — irrigated area	ha	2	1,800	3,600
TOTAL MONEY IN (ZMW)				**3,600**
2. MONEY OUT — Fixed Costs				
Solar pump (depreciation)	Season	1	650	650
Solar panels (depreciation)	Season	1	300	300
Hosepipes & fittings	Season	1	120	120
Storage tank	Season	1	130	130
Total Fixed Costs (ZMW)				**1,200**
3. MONEY OUT — Variable Costs				
Labour (pump operator)	Man-days	6	80	480
Fuel / energy (solar = 0)	Litres	0	0	0
Maintenance & repairs	Season	1	200	200
Transport to fields	Trips	4	30	120
Total Variable Costs (ZMW)				**800**
4. TOTAL MONEY OUT (Fixed + Variable) (ZMW)				**2,000**
5. PROFIT or LOSS (Money In minus Money Out) (ZMW)				**1,600**
6. Unit Cost per hectare (Total Out ÷ Area) (ZMW/ha)				**1,000**

EXERCISE 2 — Participants complete this individually or in pairs

- Fill in your own figures below. Use real numbers from your own business or the numbers given by the trainer for your area.
- When finished, calculate: What is your profit or loss? What is your break-even number of hectares?

Exercise 2: Your own IaaS Business Calculation

Table 6: IaaS business calculation exercise

Item	Unit	Qty	Price (ZMW)	Total (ZMW)
1. MONEY IN (Revenue)				
Service fee — irrigated area	ha	____	____	____
TOTAL MONEY IN (ZMW)				____
2. MONEY OUT — Fixed Costs				
Solar pump (depreciation)	Season	____	____	____
Solar panels (depreciation)	Season	____	____	____
Hosepipes & fittings	Season	____	____	____
Storage tank	Season	____	____	____
Total Fixed Costs (ZMW)				____
3. MONEY OUT — Variable Costs				
Labour (pump operator)	Man-days	____	____	____
Fuel / energy (solar = 0)	Litres	____	____	____
Maintenance & repairs	Season	____	____	____
Transport to fields	Trips	____	____	____
Total Variable Costs (ZMW)				____
4. TOTAL MONEY OUT (Fixed + Variable) (ZMW)				____
5. PROFIT or LOSS (Money In minus Money Out) (ZMW)				____
6. Unit Cost per hectare (Total Out ÷ Area) (ZMW/ha)				____

Applying the Water Pricing Tool (Practical Session)

The Water Pricing Tool operationalizes investment-grade pricing. The Water Pricing Tool is a structured financial model that helps irrigation service providers:

1. Calculate full cost of service (including depreciation)
2. Estimate cost per hectare and cost per hour
3. Determine minimum viable price
4. Simulate fuel price increases.
5. Model solar vs diesel/petrol scenarios
6. Calculate break-even service area.
7. Assess profitability sensitivity.

Step 1: Input Data

Participants enter:

- Pump cost
- Solar system cost (if applicable)
- Expected lifespan
- Annual maintenance
- Fuel consumption
- Labour cost
- Area served per season

Step 2: Automated Outputs

The tool calculates:

- Cost per hectare
- Break-even hectares
- Required seasonal revenue
- Profit margin at different price levels

Step 3: Scenario Simulation

Facilitator runs:

- 20% fuel price increase scenario
- 10% non-payment scenario
- Reduced demand scenario

Learning Outcome:

Participants understand that pricing must:

- Cover full cost (including asset replacement)
- Cover risk

- Generate reinvestment capital

Facilitators reinforce that:

Pricing is the foundation of the sustainability of the irrigation enterprise. Without disciplined tariff design, expansion pathways and investment planning collapse.

Financial Governance and Record Keeping

- Separate business and household finances.
- Budget for maintenance before the season.
- Establish depreciation reserves.

Table 7: Record keeping

Record	What to record	How often
Pump Log	Date, hours run, area irrigated, water source used	After every session
Energy / Fuel Log	Solar hours or litres of fuel used per session	After every session
Client Payment Register	Client name, area, fee charged, amount paid, balance due	At every payment
Income & Expenditure Ledger	All income and all expenses with dates and descriptions	Weekly
Maintenance Record	Equipment serviced, problem, action taken, cost, next due date	After every repair

Customer Relationship Management

Remember: News travels fast in rural Zambia. A bad deal travel faster than a good one. A successful IaaS provider knows their clients and aims to keep them by:

- Trust, reliability, transparency, and communication drive long-term client retention.

The Four P's of a successful IaaS

Table 8: The four P's of a successful IaaS

P	Principle	For Your IaaS Business
PRODUCT	The service must solve a real problem	You are selling reliable water at the right time — not just a pump
PRICE	Profitable for you; affordable for clients	Charge when farmers have cash — after harvest or at planting. Offer seasonal contracts.

PROMOTION	Clients must know you exist and trust you	Visit farmer groups, attend markets, get extension officers to refer you
PEOPLE	Keep clients happy and coming back	Be on time. Communicate delays. Resolve complaints quickly. News travels fast in rural Zambia.

Essential Contract Components:

A written contract protects both the service provider and the client. It removes room for argument and makes business dealings professional. Always use contracts even with friends and family members. A contract should contain:

- Names and contacts of both parties (provider and client)
- Agreed service area in hectares and exact location
- Agreed price, payment timing, and method of payment
- Irrigation frequency, duration, and season covered
- Responsibilities of each party
- Penalties for late payment or non-payment
- Signatures of both parties and a witness

TRAINER NOTE
- A sample service contract is provided in Appendix 8. Review it with participants. Encourage them to adapt it to their local language and context.
- Stress: a verbal agreement is not a contract. If there is a dispute, there is no proof.

Efficiency Optimization

- Cluster farm scheduling
- Preventive maintenance
- Night irrigation to reduce evaporation
- Fuel/energy efficiency practices

Risk Management

Table 9: Risk management matrix

Risk Type	Example	Likelihood	Mitigation Strategy
Environmental	Drought, floods	Medium	Diversify crops served; maintain emergency reserves

Technical	Pump failure	Medium	Preventive maintenance schedule; spare parts budget
Financial	Client non-payment	High	Written contracts; deposit upfront; payment at harvest
Market	Price competition	Low	Build loyalty through reliability and quality service
Regulatory	No WARMA permit	Low–Med	Register with WARMA and catchment council early

Value Addition & Diversification, SCALING & INVESTMENT STRATEGIES

Investment Planning for Scalable Irrigation Enterprises

Irrigation as a Service (IaaS) is not only a livelihood activity; it is an investable rural enterprise model. Sustainable expansion requires disciplined financial planning aligned with development finance principles.

Participants must evaluate:

1. Capital investment requirements (pump systems, solar arrays, storage, distribution infrastructure)
2. Working capital needs (fuel, labour, maintenance reserves)
3. Asset lifespan and depreciation schedules
4. Loan terms (interest rate, grace period, repayment schedule)
5. Return on Investment (ROI)
6. Payback period
7. Debt service coverage capacity

Investment Viability Assessment

An irrigation enterprise is considered bankable when:

1. Pricing covers full economic cost (including depreciation and maintenance reserves).
2. Cash flow remains positive throughout the agricultural cycle.
3. Revenue volatility risks are mitigated through contracts and diversification.
4. The enterprise can service debt without compromising operations.
5. Capital replacement funds are accumulated before asset end-of-life.

Investment Planning

Water pricing is the primary determinant of enterprise sustainability and investment readiness Water pricing is directly linked to

investment viability. Irrigation enterprises are only bankable when pricing structures:

1. Cover full cost including depreciation.
2. Generate surplus for reinvestment.
3. Protect against fuel and maintenance shocks.
4. Allow repayment of loans within agreed timelines.

Under pricing irrigation services leads to:

1. Inability to replace equipment.
2. Failure to repay loans.
3. Business stagnation.
4. Loss of investor confidence.

Facilitator Exercise:

Using the Water Pricing Tool, simulate:

- A loan repayment scenario.
- A solar upgrade scenario.
- A 15% cost shock scenario.

Participants assess whether current pricing sustains expansion.

Before expanding or borrowing capital, the enterprise must demonstrate:

- Positive cash flow for at least one production cycle
- Fully documented financial records.
- Signed service contracts with clients.
- Maintenance reserve fund established.
- Cost-reflective pricing validated using the Water Pricing Tool
- Asset depreciation tracked annually.

Business Health Diagnostic Questions

Use this checklist at the start and end of each season to assess the health of your IaaS business.

Table 10: Business health diagnostic checklist

Question	Yes ✓	No ✗	Action Needed
Is my solar pump in good working condition?			
Do I keep daily records of pump hours, income, and expenses?			
Is my service price covering all costs including depreciation?			

Do I keep business money separate from household money?			
Do I have signed written contracts with all my clients?			
Am I saving for equipment replacement each season?			
Are all my clients satisfied with my service?			
Do I have a WARMA water use permit?			
Have I budgeted for this season before it started?			
Have I reviewed my pricing since last season?			

Sustainability happens when revenue exceeds total costs, assets stay intact, risks are controlled, clients remain loyal, and profits are reinvested.

MODULE 3: PORTABLE SOLAR SYSTEM

Lesson objectives

1. To find out Lead Farmers' basic knowledge around the use of solar systems
2. To provide knowledge on the portable solar system
3. To demonstrate how to operate and maintain a portable solar system.
4. To show the benefits of using a portable solar system

Duration for session: 45 minutes

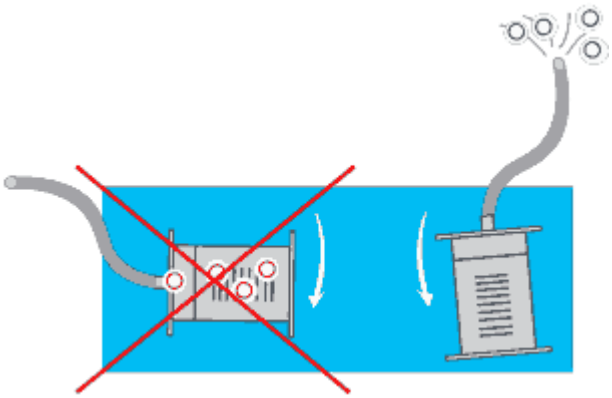
General

The portable solar pump is designed to work with solar panels and is totally dependent on the use of the sun (solar). The portable solar pump works in such a way that when there is adequate sunlight the pump is able to pump more water (increased pressure) and when there is cloudy weather, the pump reduces the amount of water being pumped (low pressure).

The portable solar pump can be used in a river, open well or stream.

Who can use the portable solar system?

The portable solar system can be used by women, men and youths because it is light weight and can be transported from one garden/field to another by carrying it. The solar panels come with a belt (handle) and the solar pump as has its own belt (handle) for carrying.



Steps in setting up the portable solar system

1. Face panels to sun with legs
2. Unroll hosepipe and connect all components
3. Put solar pump in water vertically so the air inside can escape.
4. Switch on the pump. There are two positions for switching on, one when there is full sun and the other when there is cloudy weather.



Do not put the solar panels in shade as the system will shut down for about a minute and then resume afterwards once the shadow is cleared.

Technical specification

- At 3m water level flow is 30L/min
- At 10m water level flow is 17L/min
- At 100m horizontal pipe length, flow is 20L/min

This graph shows the daily yield of the pump depending on depth of the water level and weather conditions.

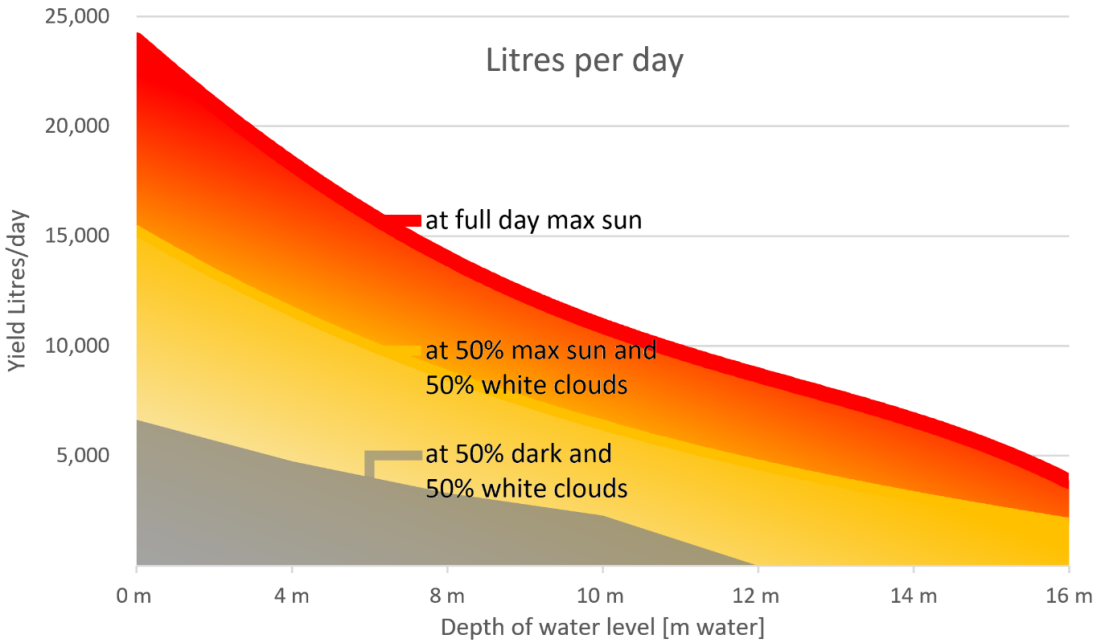
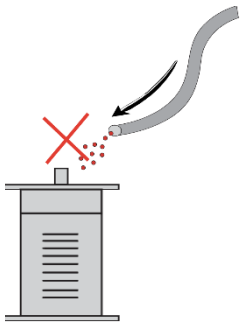


Figure 2: Pump daily yield (Source: www.portablesolarpumps.com)

Pipe cleaning

Clean pipe inside before connecting to avoid sand entering the pump.



Filter maintenance

Clean filter once in a while to prevent clogging.



Figure 3: Filter maintenance sample (Source: www.portablesolarpumps.com)

Maintenance frequency

Table 11: Filter maintenance schedule

Frequency	Task	Why It Matters
After every use	Clean filter; wipe panel surface; record pump hours	Prevents clogging and sand damage
Weekly	Check all pipe connections; inspect hoses for wear	Catches leaks before they become costly
Monthly	Test pump flow rate; check panel connectors for corrosion	Monitors performance decline early
Each season	Full system service by technician; replace worn hosepipe	Extends equipment life; maintains warranty

Annual	Update maintenance log; review depreciation; budget for replacement parts	Supports financial planning and investment

Protective delay

- After cloud cover, the pump will restart after 1 minute to stabilize the pump.
- After the well runs dry, the pump will restart after 10 minutes for water to return.
- In case of temporary shade or dry run, you can reset the delay by switching the pump off and on manually.

Benefits of the Portable Solar System

1. Easy watering – efficient on water usage
2. Easy to operate – plug and play.
3. It is easy to maintain (easy to dismantle and clean)
4. Easy to carry – portable.
5. Does not pollute the environment.
6. It is affordable by most smallholder farmers. An average farmer can pay for the portable solar system with proceeds from one harvest.
7. It can be used for income generation (business)
8. It is more secure, once used it can easily be packed and stored away in a safe place.
9. Enhances food and nutrition security as farmers are able to grow different crops even during the drier period of the year.

APPENDICES

Appendix 1. Sample Profitability Worksheet

Item	Cost (ZMW)
Fuel	
Labour	
Maintenance	
Transport	
Other Costs	
TOTAL COST	0
TOTAL INCOME	
PROFIT / LOSS	0

Appendix 2. Sample Financial Calendar

Month	Expenses (ZMW)	Income (ZMW)	Balance (ZMW)
Jan			0
Feb			0
Mar			0
Apr			0
May			0
Jun			0
Jul			0
Aug			0
Sep			0
Oct			0
Nov			0
Dec			0

Appendix 3. Keynote address

No.	Client Name	Location	Area (ha)	Service Fee (ZMW)	Amount Paid	Balance	Contact
1							
2							
3							
4							
5							
6							
7							
8							

Appendix 4. Maintenance Log

Date	Equipment	Problem	Action Taken	Cost (ZMW)	Technician	Next Service Date

Appendix 5. Fuel/Energy Log

Date	Pump ID	Litres Used	Cost per Litre (ZMW)	Total Cost (ZMW)	Operator

Appendix 6. Income and Expenditure Ledger

Date	Description	Income (ZMW)	Expense (ZMW)	Balance (ZMW)

Appendix 7. Sample Self Assessment

Question	Yes (✓)	No (✗)	Action Needed
Is my pump functional?			
Do I keep daily records?			
Are prices profitable?			
Do I separate business money?			
Do I have written contracts?			
Am I saving for replacement?			
Are clients satisfied?			

Appendix 8. Sample Service Contract

IRRIGATION AS A SERVICE (IaaS) – SERVICE CONTRACT		
1. **PARTIES TO THE AGREEMENT**		
Service Provider Name: ID / NRC: Contact Number: Location:		Client Name: ID / NRC: Contact Number: Location:
2. SERVICE DETAILS		
Crop Type: Irrigation System: Start Date:	Area (ha): Frequency: End Date:	Water Source: Duration: Season:
3. PAYMENT TERMS		
Service Fee (ZMW):	Payment Method:	Deposit (ZMW):
Payment Schedule:		
Late Payment Penalty:		
4. RESPONSIBILITIES		
Service Provider Responsibilities: ▪ Provide functional equipment. ▪ Deliver water as agreed. ▪ Maintain equipment. Client Responsibilities: ▪ Prepare the field. ▪ Pay on time.		
5. RISK & LIABILITY		
Natural Risks (drought/flood): Equipment Breakdown:		
6. WATER GOVERNANCE COMPLIANCE		
WARMA Permit Number: Catchment Council:		
7. TERMINATION CONDITIONS		
Notice Period (Days): Grounds for Termination:		
8. SIGNATURES		
Service Provider Name:	Signature:	Date:
Client Name:	Signature:	Date:
Witness Name:	Signature:	Date:





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