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Deliverable:	5.2. - Define a "pay as you irrigate" business model

Solar-based irrigation business model 'pay as you irrigate' for women empowerment, water management and food security in Mozambique

Pay as You irrigate Business Model for the solar-powered irrigation systems with the local smallholder farmers and financial institutions in Pangalata, Moamba, Mozambique

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PRACTICA HUB

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Disclaimer:

This document is an output of the Technical Assistance Response in Mozambique. The present report is the output of the project 'Solar based irrigation business model 'pay as you irrigate' for women empowerment, water management and food security in Mozambique. The views and information contained herein are a product of the international TA implementation team led by PRACTICA & HUB.

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1. Introduction

This report is part of the deliverables for the project *Solar-based irrigation business model' pay as you irrigate' for women empowerment, water management and food security in Mozambique* implemented by the consortium PRACTICA and HUB. The project's overall objective is to identify the best Solar Powered Irrigation System (SPIS) for the Pangalata association in Moamba that could be deployed using groundwater, surface water, and the possibility for rainwater harvesting. The system's design will be reinforced by the definition of a clear *pay-as-you-irrigate* business model that will be customized for the lowest-income farmers.

This document defines different scenarios for a pay-as-you-irrigate business model targeting the smallholder farmers of the Pangalata association in Moamba, Mozambique. It includes a defined *pay-as-you-irrigate* model, a detailed financial analysis of cost and revenue forecast, the annual cash flow of the association and guidelines for implementing the pay-as-you-irrigate financial modality.

2. Methodology

The following steps were followed to design the business model:

1. Process and analyze the financial data collected in the stakeholder consultation (see deliverable 5.1).
2. Interview different financial institutions and solar irrigation technology suppliers on their experiences implementing different business models for solar irrigation in Mozambique.
3. Calculate the cost and revenue structure, as well as the annual cash flow of the Pangalata Association.
4. Calculate the cost of water per m^3, and the payment terms with different financing conditions scenarios.

3. Pay-as-you-irrigate business model

The pay-as-you-irrigate (PAYI) model is an innovative financial mechanism in which users pay for the volume of water they use, which is fair and encourages farmers to keep producing. A fee that is too high could have a negative impact on the volume of water requested. Moreover, the payment terms must be defined in a way that is suitable for the farmers. The cash flow of farmers is not constant, and the volume of water they require also fluctuates within the season and cropping stage. These constraints must be addressed to ensure the business model's sustainability and, thus, the solar irrigation system. The table below presents the different strengths and weaknesses of this irrigation model.

Table 1. Strengths and Weaknesses of the PAYI business model.

Strengths	Weaknesses
Cost Alignment with Actual Usage Farmers pay only for the water they use, making the model particularly fair and cost-effective. This can be especially beneficial in regions with varying water needs due to seasonality or crop type. The model provides financial flexibility, as payments vary according to irrigation needs, reducing the financial burden during periods of low water use.	**Dependence on Technology and Infrastructure** The success of PAYI models relies on reliable technology for measuring and monitoring water usage, which may not be feasible in areas with limited infrastructure or technical capacity.
Encourages Efficient Water Use By tying costs directly to water consumption, the PAYI model incentivizes farmers to use water more efficiently, reducing waste and promoting sustainable water management practices. This model can help mitigate the impact of water scarcity and droughts by encouraging conservation.	**Potential for Limited Adoption** Farmers may be reluctant to adopt the PAYI model due to a lack of understanding or trust in new technologies and payment mechanisms. In areas with unpredictable rainfall or water availability, farmers might perceive PAYI as too risky or financially uncertain. Poor technical support from agricultural extension personnel.
Flexibility for Farmers Farmers can adjust their irrigation practices based on their financial situation, weather conditions, and other crop requirements, ensuring greater control over costs. The model accommodates diverse farming practices and crops, making it adaptable to different agricultural contexts.	**Risk of Default and Non-Payment** Farmers may struggle to understand the water consumption account system. This may cause disputes between the farmers and the supplier. In cases of non-payment, service deactivation can lead to loss of access to irrigation, potentially affecting crop yields and farmers' livelihoods.
Supports Precision Agriculture The PAYI model often incorporates advanced technologies like smart meters and sensors, which can provide valuable data for precision agriculture, helping farmers optimize inputs and improve productivity.	**Risks of fraud in water meters** Users might attempt to bypass or manipulate the water meters to reduce their recorded consumption and lower their payments. Even without malicious intent, meters can malfunction due to poor maintenance, environmental factors, or age, leading to inaccurate measurements and either undercharging or overcharging users. This could affect the financial viability of the PAYI system or cause disputes with and among users.
Potential for Cross-Subsidization PAYI models can allow service providers to cross-subsidize costs by charging slightly higher rates during high-demand periods, balancing revenues over time.	

3.1 Experiences with business models for solar irrigation in Mozambique[1]

In recent years, Development Financial Institutions (DFI) and Development Agencies (DA) such as GIZ-Endev, ENABEL, and UK Aid[2] have partnered with companies such as Solar Works, Epsilon, Engie and other local companies and piloted different business models for increasing the adoption of solar irrigation systems by smallholder farmers in Mozambique. Projects have been implemented in various provinces of Mozambique, targeting smallholder farmers and cooperatives. Usually, the DA contribute with a grant of between 50% and 70% of the irrigation system, and the farmers pay the other part (30% - 50%) divided in monthly, quarterly or semi-annually instalments for 12 to 18 months. Projects in which farmers had to pay 100% of the value of the equipment, and there was no grant for any part of the system, were not deemed successful due to the lack of payment from the farmer or the intended target group was not reached (only medium-big size farmers are the ones that can invest on a solar irrigation system without a subsidy).

Key success factors identified:

- The cases in which there was a contribution of a part of the value of the system made it easier for farmers to pay and fulfil their obligations.
- Training and capacity building for farmers to enhance their understanding and management of the irrigation systems.
- Government policies promoting renewable energy use in agriculture and providing subsidies or tax incentives for solar equipment.

Key challenges identified:

- Limited awareness and understanding of PAYI models among farmers.
- Inadequate financial products from commercial banks to adapt to PAYI.
- Very high bank loan interest rates in Mozambique.
- Commercial banks consider a high-risk activity to provide financing options to smallholder farmer associations.
- High initial costs for service providers, including equipment, installation, and maintenance, hence the importance of crop insurance.
- Difficulties in collecting payments, particularly in cases of crop failure or poor harvests.

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[1] Interviews were held with people from different organisations:

- BCI-Banco comercial e de Investimentos (Development Finance Institution)
- Epsilon Energy Solutions (technology supplier)
- Logos Industries (technology supplier)
- GAPI-Sociedade de Investimentos (Development Finance Institution)

[2] GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit); ENABEL (Belgian Development Agency); UK Aid (Foreign, Commonwealth and Development Office).

Key opportunities identified:

- BCI is developing a new financial product targeting smallholder farmers; information will be available in Q1 2025.
- Some DFI projects in Mozambique promote Pay-as-you-irrigate and Pay-as-you-go models to supply solar power irrigation and home systems in Mozambique.

3.2 Pangalata Association Cost and Revenue Forecast

The costs and revenue forecast for the Pangalata association have been done based on the information collected during the last workshop. The operational costs and average income are disaggregated for a detailed analysis in Table 2.

Table 2. Cost and revenue forecast.

	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Area (ha)	5	5	5	5	5
Number of farmers	25	25	25	25	25
Production Seasons	2	2	2	2	2
Yield Kg/Hectare/Season (Potatoes)	16 000	16 800	17 640	18 522	19 448
Year Production	160 000	168 000	176 400	185 220	194 481
Potatoe's Price (MZN/Kg)	38	38	38	38	38
Revenues	6 080 000	6 384 000	6 703 200	7 038 360	7 390 278
Operational Costs					
Irrigation system maintenance	2 000	2 000	2 000	2 000	2 000
Inputs					
Seeds	1 200 000	1 200 000	1 200 000	1 200 000	1 200 000
Fertilizer	160 000	160 000	160 000	160 000	160 000
Pesticides	880 000	880 000	880 000	880 000	880 000
Inputs Transport	32 000	32 000	32 000	32 000	32 000
Final Product Transport	480 000	504 000	529 200	555 660	583 443
Seeding Labor	80 000	80 000	80 000	80 000	80 000
Harvest Labor	160 000	168 000	176 400	185 220	194 481
Total Operating Costs	2 994 000	3 026 000	3 059 600	3 094 880	3 131 924
Investment Depreciation	200 637	200 637	200 637	200 637	200 637
Net income[3]	2 885 363	3 157 363	3 442 963	3 742 843	4 057 717
Average Annual Income per farmer	115 415	126 295	137 719	149 714	162 309
Average Monthly Income per farmer	9 618	10 525	11 477	12 476	13 526
Average Annual Labor Payment per farmer	9 600	9 920	10 256	10 609	10 979
Average Monthly Labor Payment per farmer	800	827	855	884	915
Total Annual Income per farmer	125 015	136 215	147 975	160 323	173 288
Total Monthly Income per farmer	10 418	11 351	12 331	13 360	14 441

[3] Net income is equal to Revenues – Total operating costs – Investment depreciation

3.3 Yearly cash flow for the Pangalata association

The annual cash flow of the Pangalata association is presented in Table 3. The following main assumptions were taken into account:

- Planting of the first season begins in April and the second in August;
- Harvesting of the first season starts in July and the second in December;
- The harvest from each season is sold within 3 months;
- The Association obtains the seeds on credit (5 months) as it has done until now;
- The Association is able to finance the costs of fertilizers and pesticides by themselves as it has done until now;
- Payment of SPIS is made twice a year, in the months of harvest and sale, adding up all water consumption in the respective cycle;

Table 3. Annual cash-flow Pangalata association.

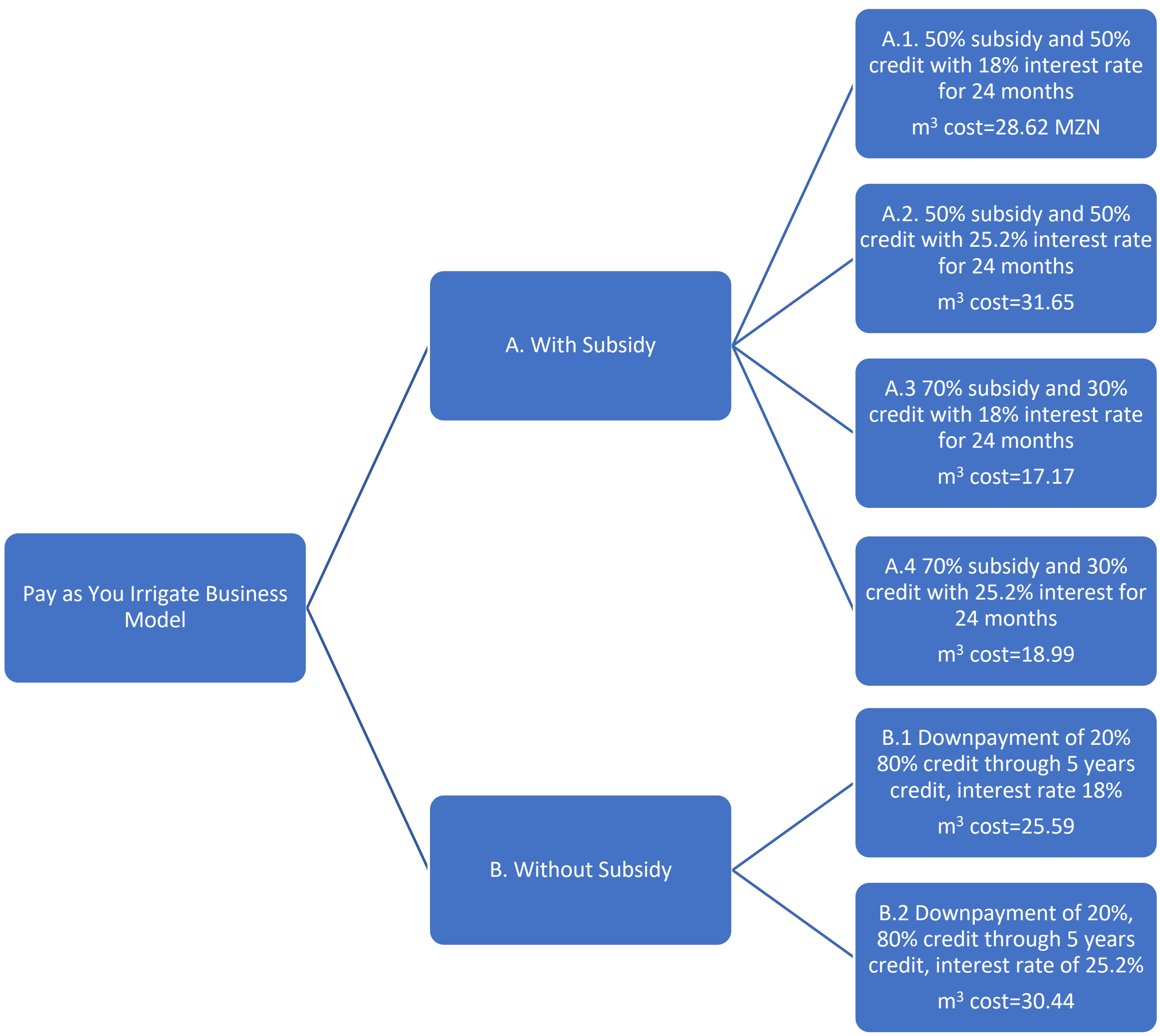
	April	May	June	July	August	September	October	November	December	January	February	March
Revenues				1 013 333	1 013 333	1 013 333		1 013 333	1 013 333	1 013 333		
Operational Costs												
Irrigation system maintenance						1 000				1 000		
Inputs												
Seeds					600 000				600 000			
Fertilizer	80 000				80 000							
Pesticides	440 000				440 000							
Inputs Transport	16 000				16 000							
Final Product Transport				80 000	80 000	80 000			80 000	80 000	80 000	
Seeding Labor				40 000					40 000			
Harvest Labor				80 000					80 000			
Total Operating Costs	536 000	0	0	200 000	1 216 000	81 000	0	0	800 000	81 000	80 000	0
Cash Flow	-536 000	0	0	813 333	-202 667	932 333	0	1 013 333	213 333	932 333	-80 000	0
Aggreggate Cash Flow	-536 000	-536 000	-536 000	277 333	74 667	1 007 000	1 007 000	2 020 333	2 233 667	3 166 000	3 086 000	3 086 000
SPIS Payment Scenario 50% Grant 2Y					566 673					566 673		
Cash Flow	-536 000	0	0	813 333	-769 340	932 333	0	1 013 333	213 333	365 660	-80 000	0
Aggreggate Cash Flow	-536 000	-536 000	-536 000	277 333	-492 006	440 327	440 327	1 453 660	1 666 994	2 032 654	1 952 654	1 952 654
SPIS Payment Scenario 70% Grant 2Y					340 004					340 004		
Cash Flow	-536 000	0	0	813 333	-542 671	932 333	0	1 013 333	213 333	592 329	-80 000	0
Aggreggate Cash Flow	-536 000	-536 000	-536 000	277 333	-265 337	666 996	666 996	1 680 329	1 893 663	2 485 992	2 405 992	2 405 992
SPIS Payment Scenario Without Grant 5 Y					506 672					506 672		
Cash Flow	-536 000	0	0	813 333	-709 339	932 333	0	1 013 333	213 333	425 661	-80 000	0
Aggreggate Cash Flow	-536 000	-536 000	-536 000	277 333	-432 006	500 328	500 328	1 513 661	1 726 994	2 152 655	2 072 655	2 072 655

3.4 Modelling different scenarios for payment terms

Based on the information gathered from the consultation workshop and the experiences of the interviewed local actors in Mozambique, different scenarios (see also figure below) have been modelled during this exercise:

A. Subsidy (grant) from a donor covering 50% and 70% of the needed investment and the remaining 30 to 50% with credit in a PAYI system with a repayment time of 24 months years.
B. No subsidy. Credit covers 80% of the total amount, and the association members contribute 20% of the needed investment of 80% over the years.

Credit terms will be considered at a moderate expected interest rate of 18% and a pessimistic interest rate of 25.2% in a normal commercial interest rate. There are financing lines with subsidized conditions in Mozambique for Renewable energy projects between 7,5% and 18%, and the commercial interest rate 25.2%.



A.1. 50% subsidy and 50% credit with 18% interest rate for 24 months.

A.1. 50% subsidy and 50% Credit with 18% Interest Rate 24 months	Year 1	Year 2	Year 3	Year 4	Year 5
Anual Payment	1,133,346.14	1,133,346.14			
2 Annual Payments	566,673.07	566,673.07			
Monthly Payment	94,445.51	94,445.51			
Credit payment per cubic meter	28.62	28.62			
Actual cost per cubic meter based on depreciation	11.45	11.45	11.45	11.45	11.45
Net income	1,752,016.76	2,024,016.76	3,442,962.90	3,742,842.90	4,057,716.90
Total Anual Income per farmer	79,680.67	90,880.67	147,974.52	160,322.52	173,287.92
Total Monthly Income per farmer	6,640.06	7,573.39	12,331.21	13,360.21	14,440.66

A.2. 50% subsidy and 50% credit with 25.2% interest rate for 24 months.

A.2. 50% subsidy and 50% Credit with 25.2% Interest Rate 24 months	Year 1	Year 2	Year 3	Year 4	Year 5
Anual Payment	1,253,347.50	1,253,347.50			
2 Annual Payments	626,673.75	626,673.75			
Monthly Payment	104,445.62	104,445.62			
Credit payment per cubic meter	31.65	31.65			
Actual cost per cubic meter based on depreciation	12.66	12.66	12.66	12.66	12.66
Net income	1,632,015.40	1,904,015.40	3,442,962.90	3,742,842.90	4,057,716.90
Total Anual Income per farmer	74,880.62	86,080.62	147,974.52	160,322.52	173,287.92
Total Monthly Income per farmer	6,240.05	7,173.38	12,331.21	13,360.21	14,440.66

A.3 70% subsidy and 30% credit with 18% interest rate for 24 months

A.3. 70% subsidy and 30% Credit with 18% Interest Rate 24 months	Year 1	Year 2	Year 3	Year 4	Year 5
Anual Payment	680,007.68	680,007.68			
2 Annual Payments	340,003.84	340,003.84			
Monthly Payment	56,667.31	56,667.31			
Credit payment per cubic meter	17.17	17.17			
Actual cost per cubic meter based on depreciation	6.87	6.87	6.87	6.87	6.87
Net income	2,205,355.21	2,477,355.21	3,442,962.90	3,742,842.90	4,057,716.90
Total Anual Income per farmer	97,814.21	109,014.21	147,974.52	160,322.52	173,287.92
Total Monthly Income per farmer	8,151.18	9,084.52	12,331.21	13,360.21	14,440.66

A.4 70% subsidy and 30% credit with 25.2% interest rate for 24 months

A.4. 70% Grant and 30% Credit with 25.2% Interest Rate 24 months	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Anual Payment	752,008.50	752,008.50			
2 Annual Payments	376,004.25	376,004.25			
Monthly Payment	62,667.37	62,667.37			
Credit payment per cubic meter	18.99	18.99			
Actual cost per cubic meter based on depreciation	7.60	7.60	7.60	7.60	7.60
Net income	2,133,354.40	2,405,354.40	3,442,962.90	3,742,842.90	4,057,716.90
Total Anual Income per farmer	94,934.18	106,134.18	147,974.52	160,322.52	173,287.92
Total Monthly Income per farmer	7,911.18	8,844.51	12,331.21	13,360.21	14,440.66

B.1 20% Downpayment, 80% credit with 18% interest rate for 60 months

B.1. 20% Downpayment , 80% Credit with 18% Interest Rate 5 Years	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Anual Payment	1,013,344.78	1,013,344.78	1,013,344.78	1,013,344.78	1,013,344.78
2 Annual Payments	506,672.39	506,672.39	506,672.39	506,672.39	506,672.39
Monthly Payment	84,445.40	84,445.40	84,445.40	84,445.40	84,445.40
Credit payment per cubic meter	25.59	25.59	25.59	25.59	25.59
Net income	1,872,018.11	2,144,018.11	2,429,618.11	2,729,498.11	3,044,372.11
Total Anual Income per farmer	84,480.72	95,680.72	107,440.72	119,788.72	132,754.12
Total Monthly Income per farmer	7,040.06	7,973.39	8,953.39	9,982.39	11,062.84
20% Contribution per member	26,666.97				

B.2 20% Downpayment, 80% credit with 25.2 % interest rate for 60 months.

B.2 . 20% Down payment, 80% Credit with 25,2% Interest Rate 5 Years	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Anual Payment	1,205,346.95	1,205,346.95	1,205,346.95	1,205,346.95	1,205,346.95
2 Annual Payments	602,673.48	602,673.48	602,673.48	602,673.48	602,673.48
Monthly Payment	100,445.58	100,445.58	100,445.58	100,445.58	100,445.58
Credit payment per cubic meter	30.44	30.44	30.44	30.44	30.44
Net income	1,680,015.94	1,952,015.94	2,237,615.94	2,537,495.94	2,852,369.94
Total Anual Income per farmer	76,800.64	88,000.64	99,760.64	112,108.64	125,074.04
Total Monthly Income per farmer	6,400.05	7,333.39	8,313.39	9,342.39	10,422.84
20% Downpayment contribution per member	26,666.97				

For the scenarios A, there are two distinct cubic meter price calculations. The first is the price per cubic meter that allows farmers to repay the full investment in the Solar-Powered Irrigation System (SPIS) within the two year credit term. This price ensures that over the course of two years, the total amount paid by farmers, based on their water usage, will be enough to cover the cost of the system. The second is the actual cost per cubic meter, which factors in depreciation (during five years). This reflects the true- long-term cost of each cubic meter of water used in the irrigation system, accounting for the gradual reduction in value of the SPIS over its expected lifespan.

For scenarios B, since the payment term is extended to five years, there is only one price per cubic meter. This price is designated to cover the cost of the system over the five-year period, without the need for a separate calculation based on depreciation, as the repayment term is longer and aligned with the system's ongoing usage.

For all financial scenarios, the volume of water consumed should be measured and reported daily (see templates and process in (3.6.2). However, to accommodate the farmers' fluctuating cash flow, the water usage volumes are proposed to be consolidated into two payments made by the end of both harvests. The editable version of the tables shown above can be found in the deliverable 5.3 Total cost/m3 of water used calculated.

3.5 What happens when credit is no longer available?

All the scenarios consider farmers to continue financing their own farming activities as usual, except for the investment of the SPIS. In the scenarios where the association is supported with a subsidy, the credit duration is 24 months (2 years), similar to previous experiences of PAYI and PAYGO in Mozambique[4]. In the scenario without the support of a donor, a five-year credit duration is considered. The reasoning behind this is the lack of a viable cost/revenue structure to pay the credit in 2 years for the farmers. After the credit duration in each scenario, there will be no need for more credit regarding the SPIS.

3.6 How to implement a Pay as you irrigate business model

3.6.1 How to read a mechanical water meter?

The strength of the PAYI business case relies on how the flow in the irrigation system is measured and controlled. The main element thus becomes the water meter. For the Pangalata association, a mechanical water meter has been included in the design; the mechanical water meter consists of a mechanical dial with lining figures showing the water consumed. The volume is represented in cubic meters. Those dials should be read in two reading steps. The first, located in the upper part, comprises a numerical lining dial with several rollers. Black roller indicators show complete units in m^3; the red roller indicators

[4] Based on the interviews with donors and financial institutions in Mozambique.

are decimals. We can find circular graduated scales with needles in the lower part, which will complete the reading[5].

The figure below represents an example of reading corresponding to 582.36 m^3.

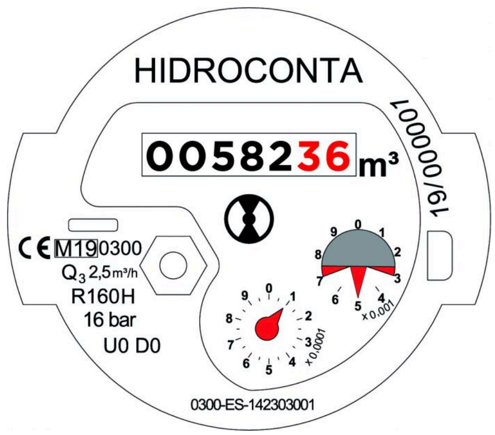


Figure 1. Water meter reading.

The readings need to be done at least monthly and recorded in a notebook, as this will be the basis for setting up the payment for the plot.

3.6.2 How can data on water consumption be collected?

The following template can serve as an organized way to collect data on the volume used per farmer to irrigate their respective plot.

Table 4. Template to gather water consumption data per farmer.

Farm Name	
Farmer's Name	
Plot ID/Name	
Crop Type	
Water Source (e.g., borehole, canal, rainwater, etc)	
Irrigation System (e.g., Drip, Sprinkler, California, etc)	
Plot Size (Ha, m^2)	

[5] https://hidroconta.com/en/articles/water-meter-reading/

Date	Time of Irrigation	Water Meter Reading (Start)	Water Meter Reading (End)	Total Water Used (m^3)	Weather conditions	Notes/Comments

Instructions for the use of the template:

1. Date: Record the date of irrigation.
2. Time of Irrigation: Note the start time and end time of irrigation
3. Water Meter Readings: Enter the water meter reading before and after irrigation. This helps in calculating total water consumption.
4. Total Water Used: Subtract the start reading from the end reading to get the total volume of water used.
5. Weather Conditions: Record the weather (e.g., sunny, rainy, windy, etc.) as it affects water needs.
6. Notes/Comments: Any additional remarks or observations can be added here

3.6.3 Required maintenance and technical support

Good maintenance and technical support must be in place to successfully implement the business model. This includes the following points:

a) Water meter calibration: Ensure the water meter is accurately calibrated to avoid discrepancies in water usage data.
b) Proper placement: Install the water meter at critical points in the irrigation system to accurately measure the water used in the plot (in this case, it is installed right after the pump).
c) Regular maintenance of the water meter:
    - Water may carry silt, debris or organic materials, which can clog or damage the meter. Routine cleaning is essential.
    - Lubrication of moving parts is necessary to avoid wear and tear of essential parts.
    - Replacement of worn-out parts, such as impellers or diaphragms, is needed to maintain accuracy.
    - Regular inspections of the irrigation network (including the water meter) are needed to identify and fix leaks, which could affect meter accuracy.
    - Periodic (at least every year, before the beginning of the irrigation season) calibration checks to ensure the water meter provides accurate data.

d) Data Management:
   - A clear routine schedule for data collection by selected people from the Pangalata association should be in place (this should include when, how and where the collected data will be stored).
   - Monitoring water usage trends will help to adjust irrigation needs, detect anomalies (e.g., overuse, leaks) and tailor future services.

e) Technical support and capacity building:
   - Local SDAE technicians need to receive training on the calibration of water meters, basic troubleshooting and repairs of the irrigation system, data handling and reporting and regular cleaning and maintenance tasks for the overall system.
   - Farmers from the Pangalata association should be trained in understanding how the water meter works and the cost structure for the pay-as-you-irrigate business model (partially done in this TA).
   - Training on water conservation techniques can help optimize water use and thus reduce costs for farmers (as they are paying per m^3 consumed).

3.7 Challenges for the implementation of a PAYI business model.

Based on the information gathered from the literature review and the interviews with relevant actors in the solar irrigation sector in Mozambique. Certain aspects have been identified as key to be closely monitored for a successful implementation of a pay-as-you-irrigate business model.

3.7.1 Risk of water meter tampering and fraud

PAYI systems rely heavily on accurately recording water usage, which means the integrity of water meters is crucial. In a country like Mozambique, where economic pressures are high and regulatory enforcement is often weak, there is a significant risk of meter tampering or manipulation. Farmers, particularly those with limited financial resources, might feel incentivized to bypass or tamper with meters to avoid higher (or any) payments, especially during dry seasons when water scarcity increases. The potential for corruption among those responsible for reading or maintaining the meters also poses a real risk. Weak governance and oversight could allow fraudulent activities to flourish, such as underreporting usage in exchange for bribes.

3.7.2 Infrastructure Vulnerability

Installing a reliable and tamper-proof water meters can be challenging due to the lack of skilled labour, limited access to remote areas, and the general fragility of existing infrastructure. Also, the harsh environmental conditions (flooding and droughts) could damage or degrade the meters, leading to inaccurate readings or complete failure of the business model. No water meter means no PAYI business model is in place.

3.7.3 Challenges with technological integration

The success of a PAYI system depends on technological infrastructure to support real-time monitoring, billing, and reporting. In Mozambique, particularly in rural areas, access to stable electricity, internet, and mobile networks is often inconsistent. This poses a challenge for implementing smart meters or remote monitoring systems, which would be necessary to reduce manual meter readings and prevent fraud. Without reliable digital infrastructure and equipment/facilities, the system could face breakdowns, leading to inaccurate billing or water supply disruptions, eroding trust in the system.

3.7.4 Social and cultural considerations

Mozambique's smallholder farmers have very limited experience with formalized water-use payment systems. Introducing a PAYI model might be met with resistance, as many farmers may not fully understand the benefits or could view the system as a threat to their livelihoods. In communities where water has traditionally been viewed as a shared resource, the commercialization of water access may be controversial, potentially leading to conflicts or non-compliance. If farmers feel the system is unfair, they might seek ways to bypass it altogether, further increasing the risk of water theft and illegal connections.

4. Another way to go: Pay as you Go.

The information presented above highlights significant challenges to implementing the Pay-as-You-Irrigate financial modality. Specifically, the operationalization of water meter readings in an environment lacking the necessary skills, access to technology, and knowledge poses a serious risk. Enforcing this model without the suitable support systems in place could lead to failure from the outset.

To address this, exploring more sustainable and proven financial models is crucial, where payment is not directly linked to the volume of water pumped into the system. A potential alternative is adopting a Pay-as-you-Go mode, where payments are distributed among all users and tailored to the annual cash flow of the production cycle. Many organizations, including national and international NGOs, DFIs, and technology suppliers, are familiar with this model and see potential for implementing it in Pangalata. In this case, the payment is tailored to an agreed scheme of fixed instalments just like the models explained in chapter 3.4, irrespective of the volume of water used. A fixed scheme reduces the level of uncertainty and complexity for both farmers and credit providers.

5. Conclusions and Recommendations

Based on the cost and revenue perspectives of potato production by the Pangalata Association on the five irrigated hectares and taking into account the growing demand for potatoes produced in Mozambique, with a relatively stable price in recent years in the Maputo region, investing in solar-powered irrigation system is economically attractive for the 25 members of the Pangalata association. Enabling the expected annual income of an average per farmer ranging from 125,000 to 173,000 Meticais, which on a monthly basis means an average monthly income between 10,400 MZN and 14,400 MZN, without considering the cost of SPIS. This is considerably higher than the average gross national income per capita in Mozambique, which is about 490 USD per year, or about 31,000 Meticais (World Bank, 2022).

Interviews revealed that some development entities have a track record of co-financing SPIS projects, covering between 50% and 70% of the costs. Combining this with a credit system offering subsidized interest rates for renewable energy projects to cover the remaining 30% to 50% could provide the association with the most straightforward path to compliance. Under these conditions, the financing could be repaid within 24 months.

If support cannot be obtained from a development entity for co-financing, the solution would be for the association and its members to contribute 20% of the value of the investment in a downpayment and finance the remaining 80% through an interest-rate subsidized line of credit with a term of 5 years. There will certainly be greater difficulty in obtaining financial resources in this model, given the lack of guarantees from the association.

In subsidized credit lines, the best method for paying credit responsibilities must be negotiated, and financing with the equipment supplier can be integrated into a PAYI model. Considering the opinion of farmers and the practice of other PAYI systems in Mozambique, a payment model in two annual instalments, at both times of harvest and sale by the association, reduces the risk of non-compliance by the association.

Comparing both options, financial support is recommended to be mobilized from donors of a development entity that could co-finance between 50 and 70% of the total investment in SPIS. The remaining amount could be obtained through a credit line with a subsidized interest rate for renewable energy to be paid in 2 years, with payment at the end of the harvest season.

Finally, the consortium recommends exploring the option of decoupling payments from the volume of water consumed by the system (see point 3.7), which would result in a PAYGO system.

6. Sources

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