

PartnerAfrica Project “Use of solar energy in the cocoa (food) sector”

Presentation at the Off-Grid Workshop at the Intersolar 2022

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SOLAR GHANA COCOA

german cooperation
DEUTSCHE ZUSAMMENARBEIT

AGI
Association of Ghana Industries

BSW
GERMAN SOLAR ASSOCIATION

Supported by the Special Initiative on Training and Job Creation

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German Solar Association

TASK	To represent the solar industry in Germany in the photovoltaic and thermal and storage sector
VISION	A sustainable global energy supply provided by solar (renewable) energy
ACTIVITIES	Lobbying, political advice, public relations, market observation, standardization
EXPERIENCE	Active in the solar energy sector for over 40 years
REPRESENTS	More than 700 solar producers, suppliers, wholesalers, installers and other companies active in the solar business from all over the world
HEADQUARTER	Berlin

Main objective of the PartnerAfrica (sequa) Project “Use of solar energy in the cocoa (food) sector”

The German Solar Association (BSW-Solar) supports the Association of Ghana Industries (AGI) and selected organizations within the renewable energy and cocoa sectors in Ghana, **to promote the use of renewable energy technologies, in particular solar energy, within Ghana’s food processing – specifically- in the cocoa sector**

Project duration: December 2021 – November 2023

Structure of the project

- **Cluster 1:** Strengthen the Energy Service Centre (ESC) of AGI, with focus on the food processing sector. The project will assist ESC to embed services for small and medium sized food processing companies beginning with the cocoa sector.

- **Cluster 2:** Support farmers through multipliers (mainly cocoa cooperatives) in the sustainable use of solar energy. The project will assist, train and educate cocoa farmers on the use of solar energy technologies and how they can be financed.

- **Cluster 3:** Establish AGI Working Group of Solar Companies to promote the use of solar technologies within the agriculture and food processing (cocoa) sectors. The project will provide trainings for working group members as well as create business linkages between the solar companies, the cocoa processors and farmers.

SPIS Business case calculation, main takeaways….

1. **Solar powered irrigations systems (SPIS) are long term investments with the potential to (more than) double the cocoa yields and improve crop quality**
2. **Not “kWh saved” or “kWh sold” are the main drivers of profitability but crop yields**
3. **The calculations prepared suggest that SPIS are worthwhile investments also for the majority of smallholder farms provided that the available water resources are known.**
4. **Be aware of the risk of over-exploitation of water resources: pumping water when it is not needed poses a potential threat : “free solar power” could deplete water resources with severe consequences**
5. **Many factors define the economic performance of SPIS but QUALITY is key: if a dysfunctional system is installed, the value added is seriously limited.**

Background:
Cocoa agriculture in Ghana

- Around 800,000 cocoa farms in total
- Typical farm size: 1-2 hectares, 70% of farms are < 5 hectares
- Only a very limited number of farms uses irrigation, most farms rely on rain-fed production only.
- The main source of income for the farmers is cocoa but there may be other sources of (agricultural and non agricultural) income
- The sales prices for cocoa are fixed by the Ghana Cocoa Board (COCOBOD)
- Many farms are not connected to the electricity grid
- Support programs for SPIS exist, e.g. Mondelez, GIZ, COCOBOD, etc.

A useful resource: the SPIS toolbox

- The analysis for business case was undertaken by using resources from the SPIS toolbox, most notably the water requirements tool, the farm analysis tool and the payback tool
- Parties involved: the German Federal Ministry for Economic Cooperation and Development (BMZ), Duke Energy, the United States Agency for International Development (USAID), the Swedish International Development Cooperation Agency (Sida) and the Overseas Private Investment Cooperation (OPIC)
- The toolbox is today taken care of by GIZ and FAO and available on energypedia at https://energypedia.info/wiki/SPIS_-_Get_Informed

→ This is a very useful resource in order to develop the basic expertise for SPIS systems

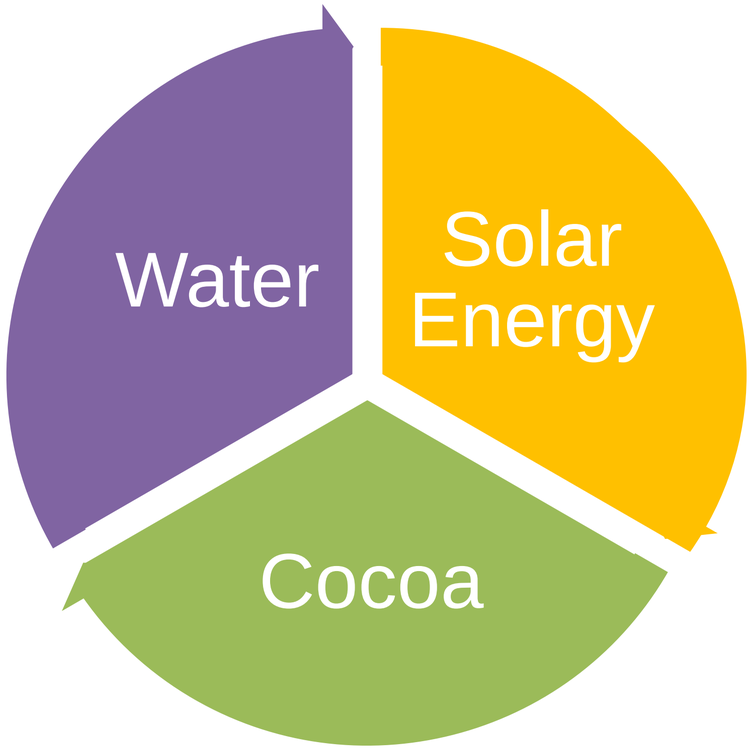
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Food and Agriculture Organization of the United Nations

Source: SPIS toolbox

Solar powered irrigation systems:
The nexus between Water, Energy and Cocoa

- Quantity: How much water?
- Source: Where to take the water?
- Pump: How to extract the water?
- Timing: When to irrigate?
- Fertilizer: irrigate (only) or fertigate?
- ……



- Power needs (kWh)
- Irradiation
- Single or multiple use?
- ……

- If done correctly, both quantity and quality of cocoa pods may increase substantially
- This will then also increase the income and the standard of living of the farmer and his family

Solar powered irrigation systems can (more than) double the cocoa yields and improve crop quality

Rainfed only

(ca. 40% - 60% of crop water requirement (CWR) covered)

500 kg / ha /p.a.

(additional) Irrigation

(<100% of crop water requirement (CWR) covered)

At least double the yield:
1,000 kg/ ha/ p.a.

….even up to
3,000 kg / ha/ p.a.

…but a number of farm specific factors play a role, e.g. natural conditions, plant type & age, line spacing, fertilization, chemigation…

Source of picture: https://pxhere.com/en/photo/1172753

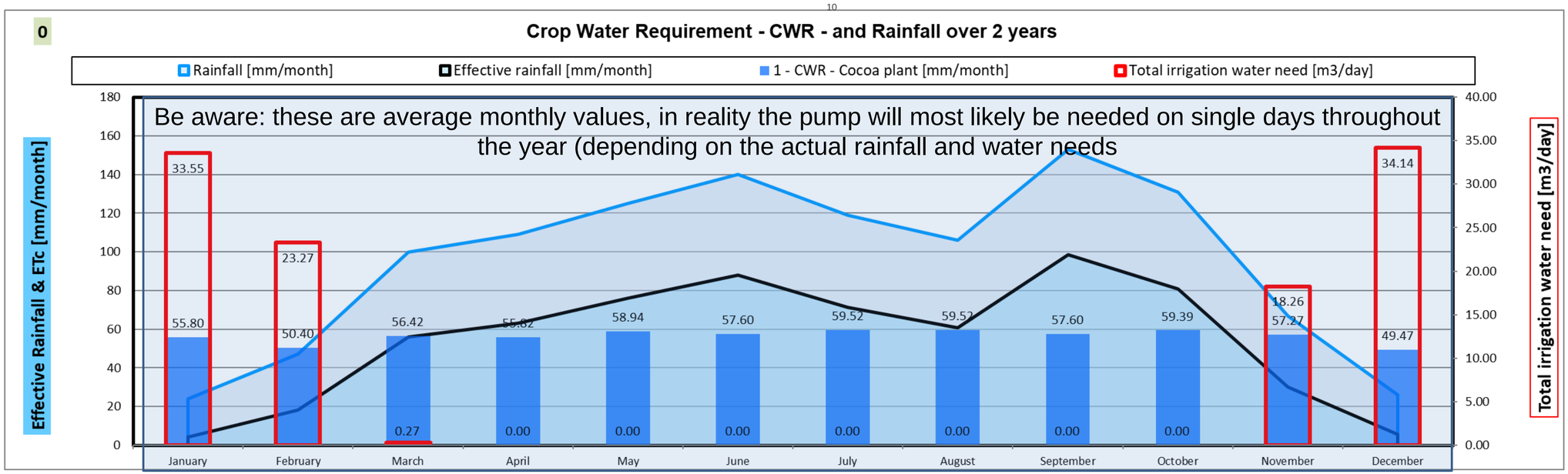
Water requirements tool:
Irrigation requirements are unique to every farm (used for base case)

Assumptions (default case)

- **Calculation method:** Reference evapotranspiration
- **Cultivated area:** 4.5 acres (1.82 ha)
- **Crop:** Cocoa plant
- **Irrigation method:** Drip irrigation
- **Irrigation efficiency:** 90%
- **Cropping density:** Normal spacing

Results

- **Highest irrigation need:** February
- **Maximum daily irrigation need:** 34.14 m^3
- **Pump utilization rate:** 27%



Source: SPIS toolbox

Farm analysis tool:
Based on cocoa income alone, most Ghanaian smallholder farmers do usually not have the means to invest

Sales					
	Area:		Yield per acre (kg)	Unit Price (GHS/ kg)	
Cocoa	4.50 acres (1.8 ha)	*GHS*	202	10.56	9,615

7 FARM INCOME STATEMENT					EUR TOTAL	GHS per acre	GHS per ha	EUR per acre	EUR per ha
	Farm code/name			0					
+ Gross value of seasonal crop production	0	*GHS*	+	0%					
+ Gross value of seasonal crop by-product production	0	*GHS*	+	0%					
+ Gross value of perennial crop production	9,615	*GHS*	+	100%	1,249.99 €	2,137 GHS	5,280 GHS	277.78 €	686.40 €
+ Gross value of perennial crop by-product production	0	*GHS*	+	0%					
+ Gross value of livestock production	0	*GHS*	+	0%					
+ Gross value of livestock by-product production	0	*GHS*	+	0%					
+ Gross value of other income	0	*GHS*	+	0%					
- Anticipated losses of total sales (reduction factor)	0%	*%*							
= GROSS FARM INCOME	**9,615**	***GHS***	=	100%	**1,249.99 €**	**2,137 GHS**	**5,280 GHS**	**277.78 €**	**686.40 €**
- Total fixed costs	5,400	*GHS*	+	80%	702.00 €	1,200 GHS	2,965 GHS	156.00 €	385.48 €
- Total variable costs	1,350	*GHS*	+	20%	175.50 €	300 GHS	741 GHS	39.00 €	96.37 €
= TOTAL COST	**6,750**	***GHS***	=	**100%**	**877.50 €**	**1,500 GHS**	**3,707 GHS**	**195.00 €**	**481.85 €**

Source: SPIS toolbox, own calculations based on research

Farm analysis tool:
Details, based on research

A farmer with an income of around 10,000 GHS has a total of around 30% that he can spend on paying back investments, e.g. in a SPIS system

7 FARM INCOME STATEMENT			EUR	GHS	GHS	EUR	EUR
			TOTAL	per acre	per ha	per acre	per ha
=	GROSS FARM PROFIT for the period 2021 to 2022	2,865.35 *GHS*	372.49 €	637 GHS	1,573 GHS	82.78 €	204.55 €
	Farm Profit Margin	30%					
	Average profit per Acre for seasonal crops:	no crops	*GHS per Acre*				
	Average profit per Acre for perennial crops:	2,137	*GHS per Acre*				
	Average profit per head of livestock:	no livestock	*GHS per head*				
	Total crop area under cultivation:	4.50	*Acre*				

Observations from interviews (annual profits available for savings and investments):

- Sefwi Bekawi Youth in Cocoa production: 2,000 GHS p.a.
- ABOFCA Co-operative Cocoa Farmers and Marketing Society ltd. 1,280 GHS p.a.
- Assinman Co-operative Cocoa farmers and Marketing Union ltd. Not provided
- Asunafo North Municipal Cooperative Cocoa Farmers and Marketing Union ltd. 3,168 GHS p.a. (max)
- Offsino Fine Flavour Cooperative Cocoa Farmers and Marketing Society ltd. Not provided

Source: SPIS toolbox, own calculations based on research

Payback tool:
Base case assumptions
Farm analysis and Irrigation system (EUR [approx. USD])

Farm analysis, before irrigation		
Total agricultural cocoa land	Acre	4.5
Total agricultural cocoa land	ha	1.8
Yearly crop yield, before irrigation	kg/ ha	500
Crop price, start year	EUR/kg	1.27
Gross farm income	EUR p.a.	1,154
Total fixed costs	EUR p.a.	648
Total variable costs	EUR p.a.	162
Gross farm profit	EUR p.a.	344
Annual profit margin increase	%	10.0%
Water levy	EUR per m³	-

Irrigation system		
Irrigation System type	#	Microirrigation: Drip irrigation
Irrigation Efficiency	%	90%
Average Evapotranspiration	mm/day	2.0
Maximum daily irrigation water nee	m3/ day	34
Average daily irrigation need	m3/ day	8.6
Yearly irrigation water need:	m3 p.a.	3,136
PV system size	kWp	3.0
Pump size	kWp	2.5
Size of water reservoir	m3	17.2

- The farm has 4.5 acres of agricultural land (1.8 ha)
- Crop yield without irrigation was estimated to be 500kg/ha
- Gross farm profit available for investments is 2,865 GHS/ year
- No water levy is paid

- A drip irrigation system was proposed because of the high irrigation efficiency
- Maximum daily irrigation need is 34m^3, on average 8.6 m^3 per day are needed

Source: SPIS toolbox and own calculations

Payback tool:
Base case assumptions
Revenues and Finance (EUR [approx. USD])

Revenues		
Time horizon	Years	25
Crop yield increase	%	200%
Crop yield	kg/ ha	1,500
Crop price	EUR/kg	1.27
Gross farm income	EUR p.a.	3,462
Total fixed costs	EUR p.a.	648
Total variable costs	EUR p.a.	162
Gross farm profit	EUR p.a.	2,652
Annual profit margin increase	%	10.0%

- After the installation of the SPIS system, the average yield increases to 1,500 kg/ha
- Costs remain stable; costs for fertilizers could even be reduced due to a more efficient application
- Annual farm profit available to payback the system is 22,096 GHS
- Yearly increase of profit margin is 10% p.a. (just above inflation of 9.3%)

Financing			
Total system costs (unsubsidized)		EUR/ha	5,763
Total system costs (unsubsidized)		EUR	10,496
Subsidies		EUR	-
Total system costs (subsidized)		EUR	10,496
O&M costs		EUR p.a.	840
Debt (Gearing)	-	EUR	-
Loan Tenor		Years	2.0
Debt Interest Rate		%	35%
Equity		EUR	10,496
Years of savings needed for equity		years	6.5
Discount Rate		%	12.0%
Longterm Inflation Rate		%	9.3%

- (One time) Total system costs are at 87,463 GHS (= 48,028 GHS/ ha)
- 3,000 EUR (25,000 GHS) are paid as subsidies
- O&M costs are around 7,000 GHS/ year
- Bank financing is not available and hence not used

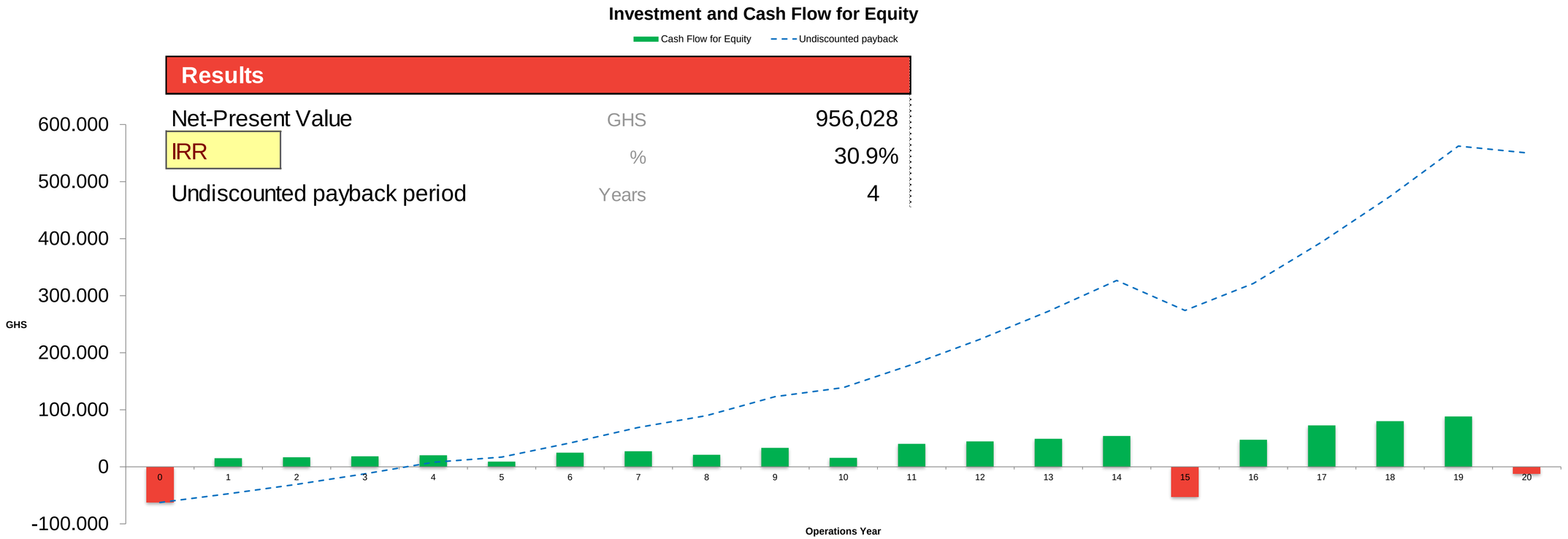
Source: SPIS toolbox and own calculations

Base case assumptions:
The role of currency exchange rates

- Most key components of SPIS systems need to be imported and are paid for in USD (or EUR)
- Component prices are hence subject to the exchange rate fluctuations between the USD (EUR) and the Cedi;
- In the last 2 years, the cedi has devaluated against the USD which means that the exported SPIS components have become more expensive in Ghana

Source: XE converter, 05.04.2022, https://www.xe.com/currencycharts/?from=GHS&to=USD&view=2Y

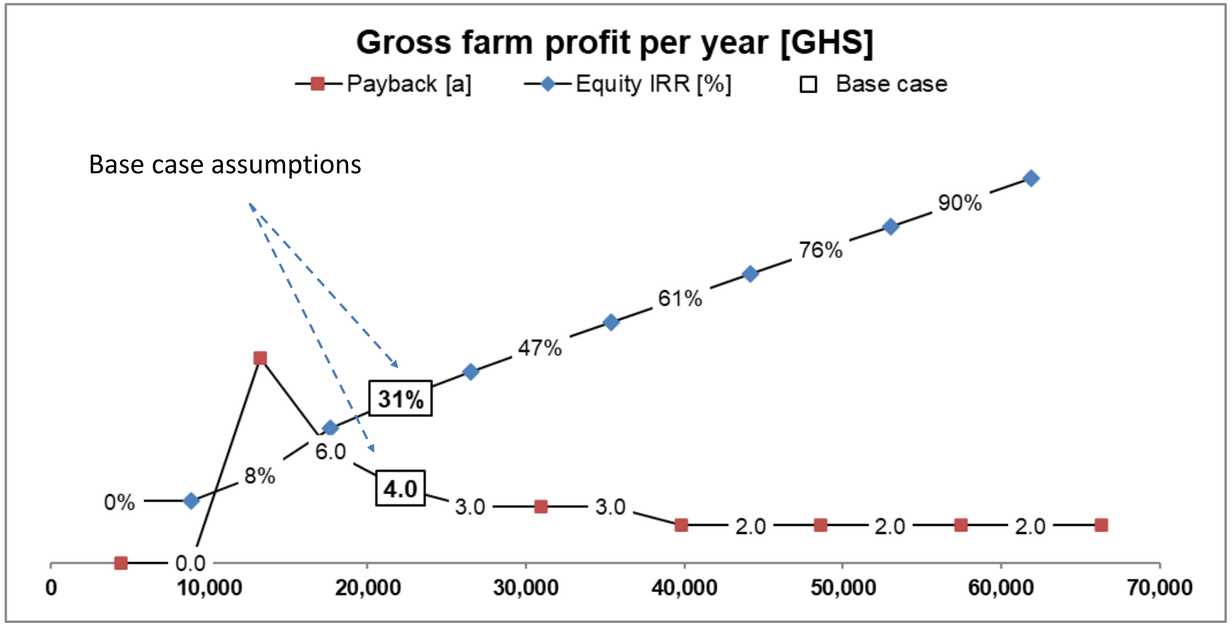
Payback tool: Results

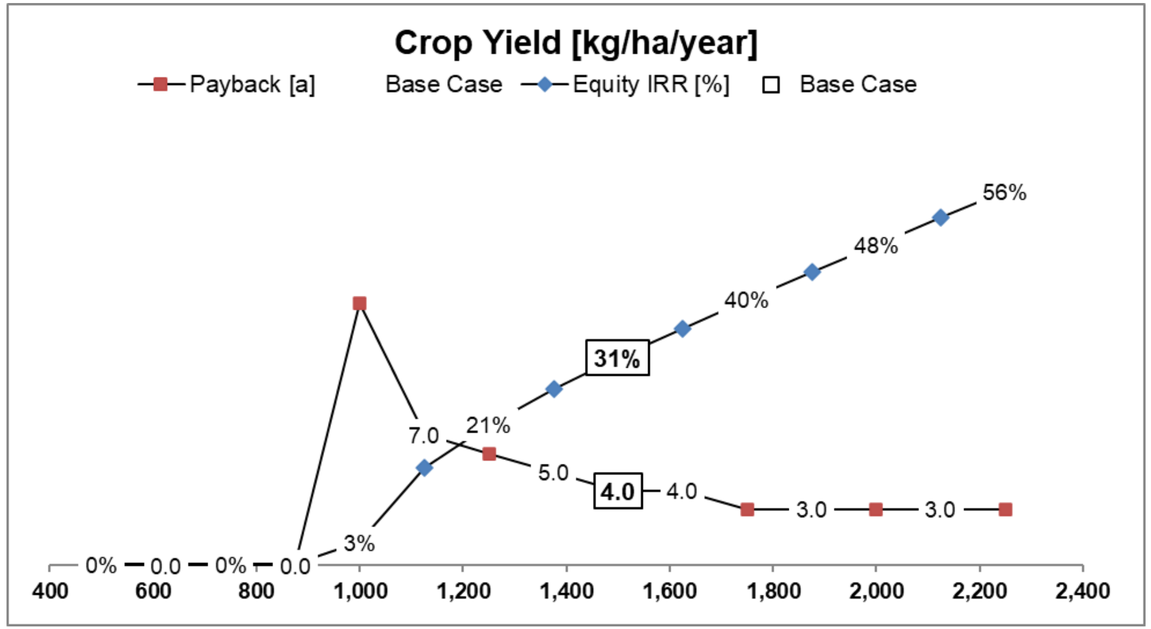


- The SPIS system under the basic assumptions is paid back after approx. 4 year
- The ups and downs of the yearly cash flows are linked to replacement of system components, O&M costs and changes due to inflation and yearly profit margin increases
- Annual farm profit available to payback the system is 22,096 GHS

Source: SPIS toolbox and own calculations

Scenario analysis, longer and shorter payback periods: Gross farm profit and crop yield

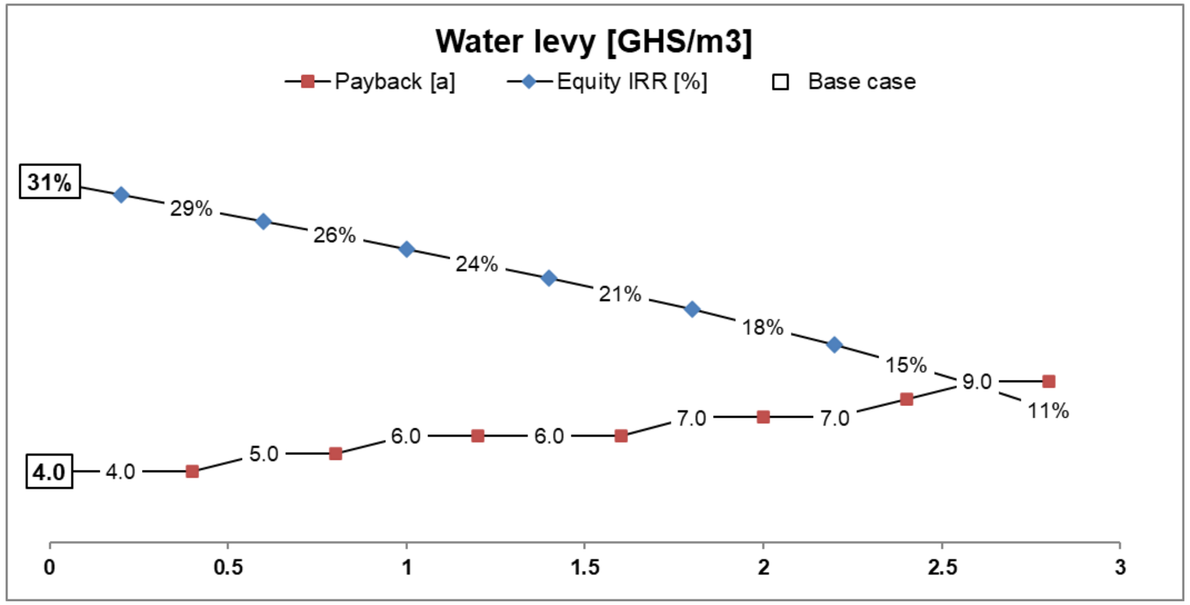


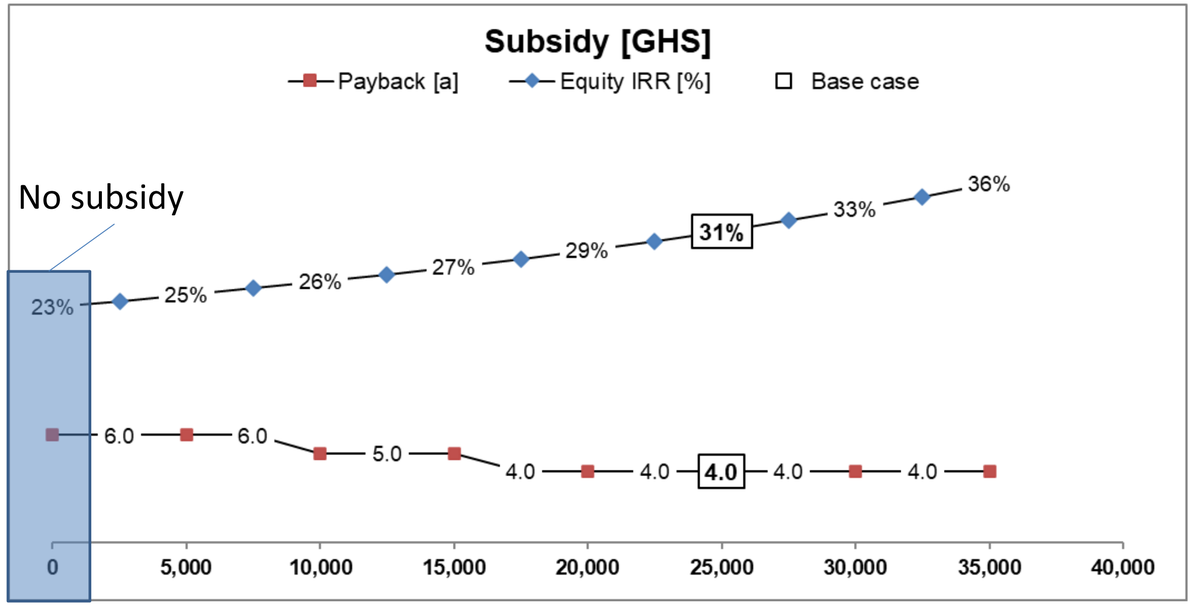


- A minimum gross profit of > 10,000 GHS (used 100% for payback) is needed to pay back the system
- This farm profit could be generated starting from a crop yield of > 900 kg/ha/year
- The higher the crop yield and the gross farm profit, the shorter the payback period: in case > 1,800 kg/ha/ year could be harvested regularly in the future, the payback would be less than 3 years

Source: SPIS toolbox and own calculations

Scenario analysis:
The effects of a water levy and subsidies



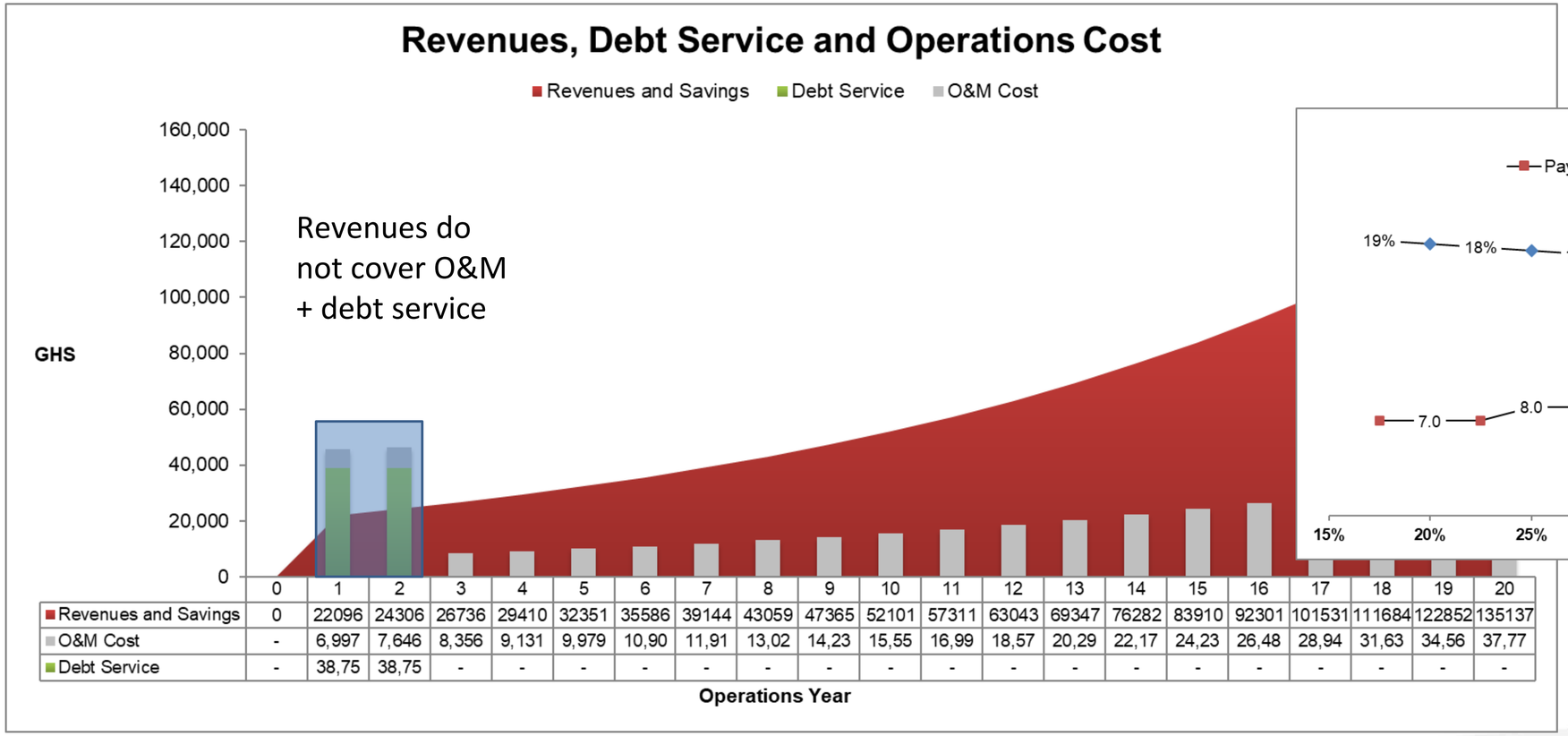


- Most farms/ cooperatives reported that no water levy needs to be paid. If a water levy were to be paid, the payback period would be increased. At 1 GHS/ m3 payback would be at 6 years.
- A water levy increases the profitability of a business case but could serve as an incentive to save water and avoid over extraction of water when it is not needed.
- Also without a subsidy the purchase of a SPIS system would still be a viable investment. Without subsidies, the payback period would increase to 6 years and the IRR would be reduced to 23%

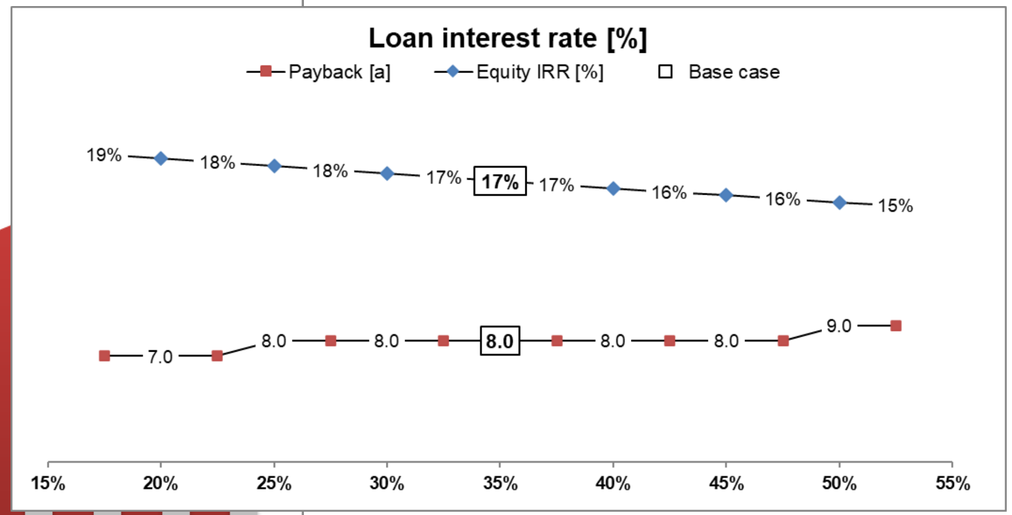
Source: SPIS toolbox and own calculations

Scenario analysis:
Loan tenor

A loan tenor of 2 years with a 35% interest rate could not be re-imbursed by additional income alone because of the high loan repayments in year 1 and 2; still he investment could be paid back



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenues and Savings	0	22096	24306	26736	29410	32351	35586	39144	43059	47365	52101	57311	63043	69347	76282	83910	92301	101531	111684	122852	135137
O&M Cost	-	6,997	7,646	8,356	9,131	9,979	10,90	11,91	13,02	14,23	15,55	16,99	18,57	20,29	22,17	24,23	26,48	28,94	31,63	34,56	37,77
Debt Service	-	38,75	38,75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-



Source: SPIS toolbox and own calculations

Recommendations & benefits

Capacity building & know-how transfer:

- Experts are needed to train / inform farmers, cooperatives, financing institutions, system suppliers of SPIS and potentially other stakeholders on:
  - System configuration
  - Operation and maintenance

Monitoring and data gathering:

- It is important to investigate existing “non functional” SPIS, re-invigorate (or replace) these systems to make sure that high quality systems are installed and the image of SPIS is not unduly damaged
- There were large variations with regards to some parameters used for the calculations in this report. Long term data and remote monitoring systems of “best in class” SPIS are needed to measure (not estimate) crop water requirements
- In order to see what kind of system works for which farm and to demonstrate that crop yields can be increased permanently and substantially, data from installations, potentially from different sites, needs to be gathered, monitored and analysed.

Pilot site:

- Planning of a pilot site could be done;
- In order to assure that measurements and permanent system improvements are also conducted after the end of the “PartnerAfrica” project a pilot installation could be installed.

(Long term) Benefits of the above mentioned recommendations:

- Once training is deployed and SPIS data is available, it can be used to convince more donors, investors and banks to finance SPIS; an effective payment collection scheme will have to be implemented
- The more successful SPIS systems are deployed, the cheaper the systems could become which will make the investment into SPIS more attractive also for the more risk-adverse investor

Next step: the search for potential investors

Please talk to us!

Contact

Thank you very much!

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