Mini-Grid Viability Model

Overview of Farmer Economics by Site

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Recap: The ATA and Duke have built a model that simulates a farmer's P&L under different circumstances, including changing energy source

Simplified Overview of 'Viability Model'

Key Inputs[1]

Site Inputs	Crop Farmer Land Size Water Depth
Irrigation Practices	Volume of Water Pumped Drip / Furrow Irrigation Pump sharing
Energy Costs	Diesel - Diesel Price - Pump Efficiency Electricity - Electricity Tariff - Pump Efficiency - Pump costs

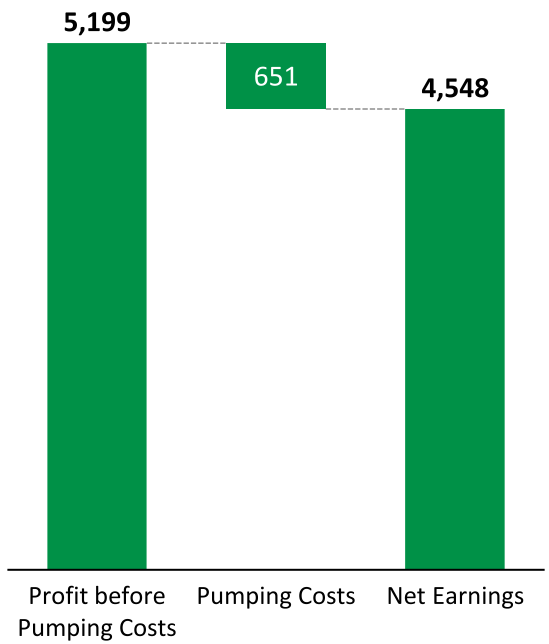
P&L Model

Revenue Modelling	*Land cultivated* *Productivity* *Post harvest loss* *Marketable surplus* *Crop Price*
Farmer Revenue	
Non-Irrigation Costs	*Inputs* *Labour*
Non-Irrigation Costs	
Profit Before Pumping Costs	
Irrigation costs	Diesel / Electricity Maintenance and repair Other costs (eg lubrication) Capex
Cost of Pumping	

Farmer Net Profit

Example - Average Weekly Farmer Net Profit, Lelicho, ETB

Current practices, Diesel Irrigation



Enables comparison of farmer economics under Diesel-powered irrigation and Electric irrigation under different circumstances

Note: (1) key inputs presented on the slide are not exhaustive

A farmer can save up to 412 ETB/week and 21K ETB annually by switching to electric pumps at 13 ETB/KWh tariff

Key inputs

Generic inputs

- System = ***Furrow, decentralized***
- Commodity cultivated = ***Avocado & Banana***
- # of SHFs = ***312***
- Water pumped/SHF/week = ***51 m³***
- *# of weeks irrigated* ***= 52***

Diesel

- Diesel price = ***30 ETB/lit***
- # of SHFs sharing pump = ***78***

Electric

- Electric pump energy requirement = ***0.35 KWh/m³***
- Electricity demand = ***18 KWh/week***
- Electricity tariff: ***13 ETB/KWh***
- # of SHFs sharing pump = ***8***

Diesel powered irrigation

Av Weekly irrigation cost by a farmer
Current practices, river, depth = 85m

Cost[1]	ETB	Remark
Diesel	614	• ~20 lit at 30 ETB/lit
Lubricant	15	• 2.5% of fuel
Travel to buy diesel	19	• 1 trip/week at 50 ETB/trip
Maintenance & repair	2	• Regular maintenance every 2 weeks at 300 ETB • 1 service / year at 1K ETB / service
Total cost	**651**	

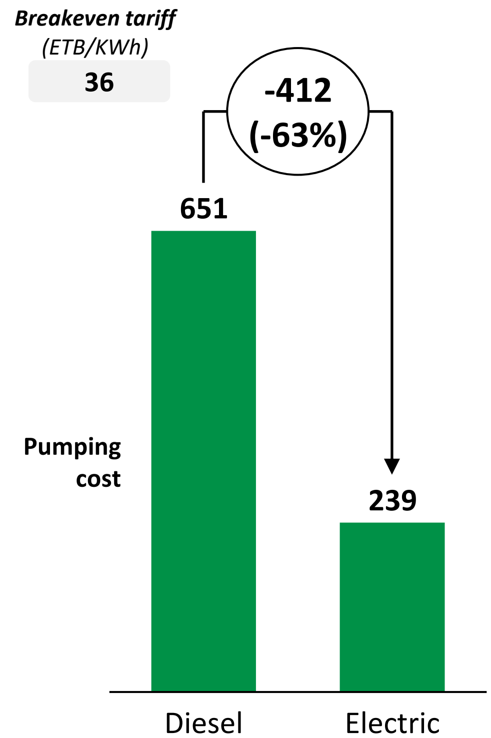
Electricity powered irrigation

Av Weekly irrigation cost by a farmer
Current practices, GW, depth = 85m

Cost	ETB	Remark
Energy (KWh) required	18	• ~51 m³ of water pumped
Electricity cost per KWh	13	• ~18 KWh needed to pump 51 m³
Total	**239**	

Cost comparison per farmer

Average Weekly irrigation cost by a farmer



Annual saving **21K ETB**

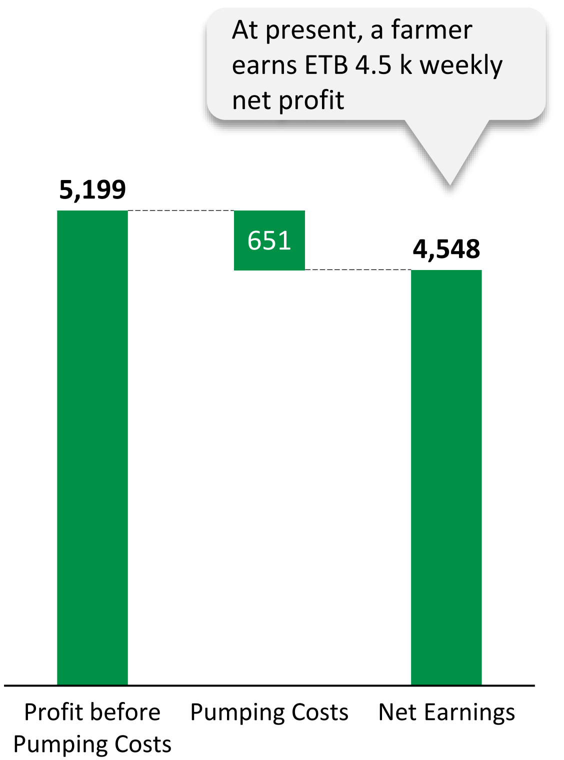
Note: (1) Cost is calculated per farmers (2) Breakeven analysis takes pumping investment into consideration using 18% capital recovery factor; this might be different from the breakeven cost in the model

Put differently, if the tariff was 36 ETB and they pumped the same amount of water, they would make the same profit as they do today

Average Weekly Farmer Profit, Current Practices, Diesel

Farmer weekly Net earning

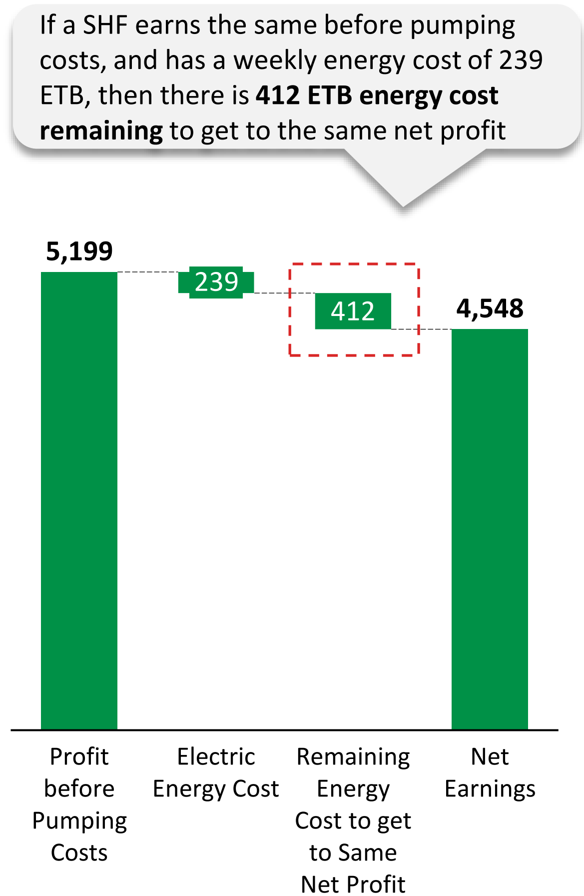
ETB



Average Weekly Energy Costs for Breakeven Profit (Same pumping practices)

Farmer weekly Net earning

ETB



Energy Costs for Breakeven Profit

Energy Cost to Get to Same Profit	*ETB 651*
Electricity Required (Electric Pump)	*18*
Breakeven Tariff	***36 ETB (USD 0.80)*** [1]

At a tariff of ETB 36, a farmer would earn ~4.5k – the same as they do today

Note: (1) 45.05 ETB USD to ETB conversion rate used

Under current irrigation practices and diesel prices for farmers, at ETB13 per KWh, farmers would save money in all selected sites

Impact on Average Weekly Costs of Switching to Electric Pumping

No other change in practices

Assumed Energy Tariff of 13 ETB/Kwh

	Selected Key Inputs			Pumping Cost (ETB)			
	Primary crop	**Diesel Price per Litre** *ETB*	**Water pumped / farmer / week** *m^3*	**Diesel Pumping**	**Electric Pumping** *at 13 ETB per KWh*	**Difference**	**Breakeven Electricity Tariff** ETB / KWh (USD / KWh)[2]
Lelicho	Avocado & bananas	30	51	651	239	-412 *-63%*	36 *(0.80)*
Murche	Banana & mango	25	110	813	590	-223 *-27%*	30 *(0.66)*
Huluku	Onion & tomato	35	286	790	397	-393 *-50%*	44 *(0.98)*
Chefe Kora	Onion & tomato	25	83	171	139	-32 *-19%*	33 *(0.73)*
Telbo	Onion	30	205	663	401	-262 *-40%*	39 *(0.87)*
Telifa	Onion & tomato	30	190	526	264	-262 *-50%*	44 *(0.98)*
Andega	Onion & tomato	27	100	259	131	*-128* *-49%*	41 *(0.91)*
Aregawi	Onion & tomato	26	47	202	56	*-146* *-72%*	48 *(1.07)*

Note: (1) Diesel prices range from 25 – 35 ETB/lit depending on the location of the mini-grid site and the ease of access to diesel on those sites (2) 1 USD = 45.05 ETB

However, the benefits are greater than purely cost on an ‘as-is’ basis, with increased uptime and opportunity to increase irrigation volumes

1 Increased uptime

- Diesel pumps start **breaking down regularly after 2 years** of usage
- Majority of pumps on the 10 pilot sites are currently un-operational
  - On average **42% of the pumps were un-operational** during Veritas site visit
- A **conservative 25% down time** assumption is used in the analysis as 42% is a snap-shot view in time
- **Electric pumps do not break down as often as diesel pump**s and require relatively less maintenance

2 Increase irrigation supply

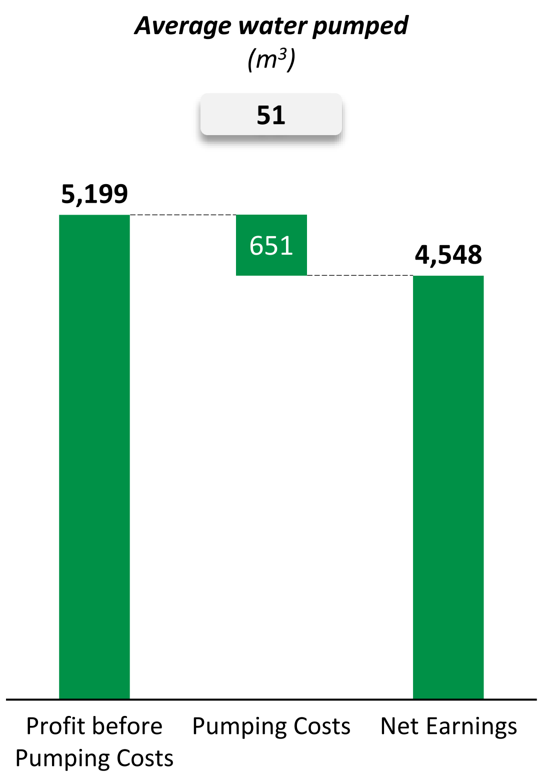
- **Improved irrigation infrastructure** will provide more reliable access to water sources
- As a result, farmers will be able to **increase the irrigation** to their fields
- This will drive **increased productivity**, **production**, and **revenues** to farmers

Including increased uptime makes the economics significantly more compelling due to productivity gains

Weekly Farmer Profit, Current Practice, Diesel

Average Weekly irrigation cost by a farmer, ETB

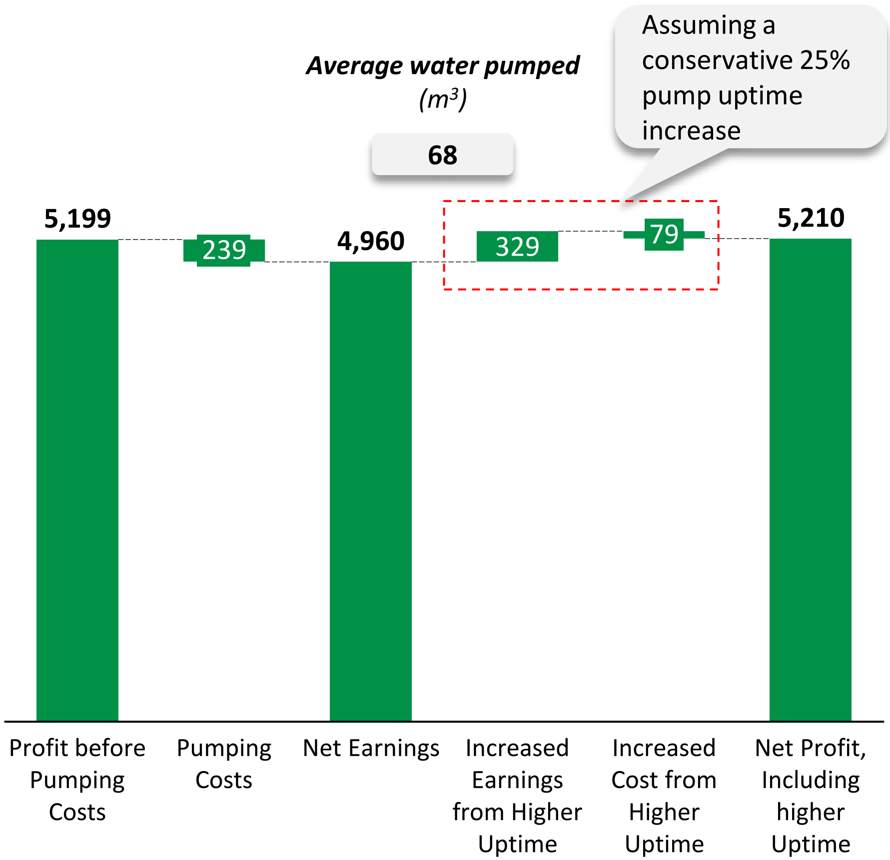
Current practice, river, depth = 85m



Weekly Farmer Profit, Increased Uptime, Electric

Average Weekly irrigation cost by a farmer, ETB

Increased uptime, GW, depth = 85m

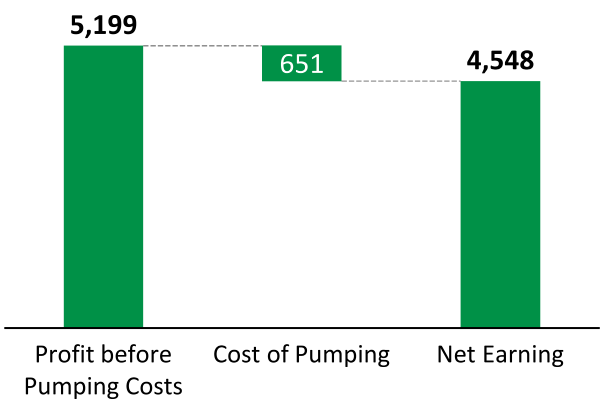


Similarly, increasing average weekly water usage to optimal levels drives further benefits

Note – Depends on Water Availability

Diesel profit at current water volume pumped

Water pumped = 51 m^3



Electric profit at current water volume pumped, *increased uptime*

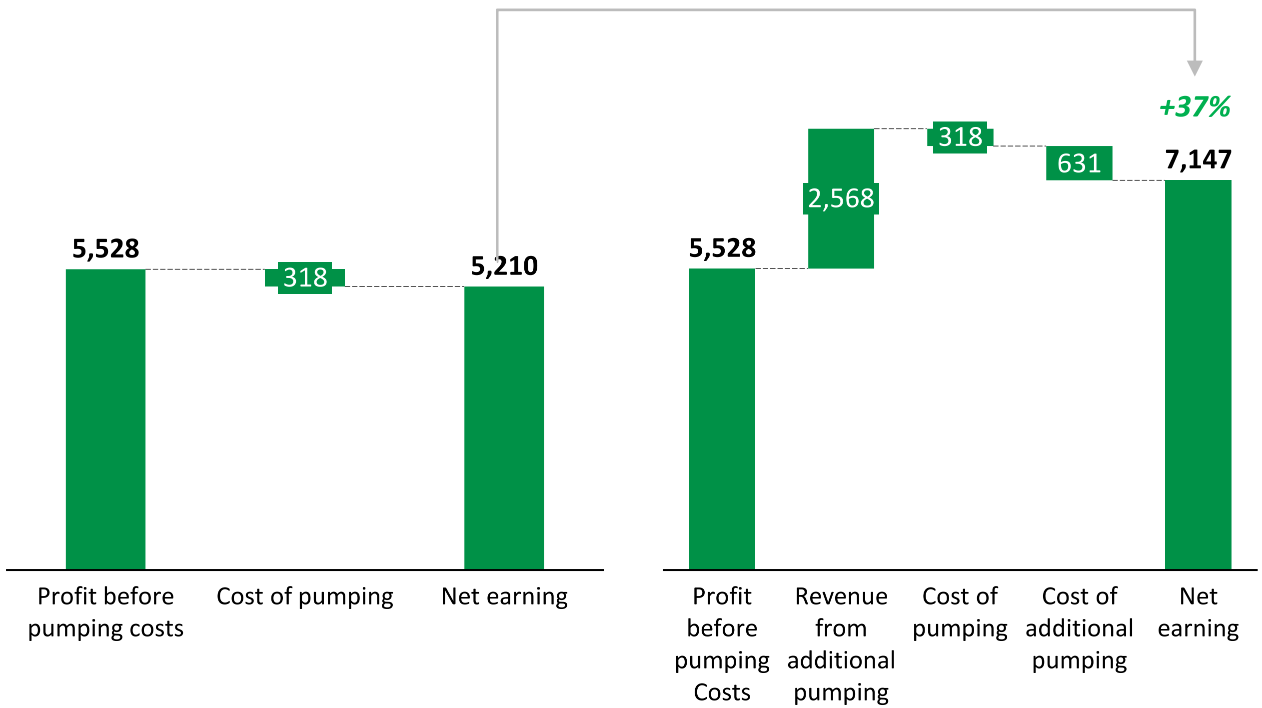
Water pumped at 10 ETB/KWh = 68 m^3

Assumed tariff	*Breakeven tariff*
13 ETB/KWh	36 ETB/KWh

Electric profit at increased water volume pumped[1]

Water pumped at 10 ETB/KWh = 76 m^3

Assumed tariff	*Breakeven tariff*
13 ETB/KWh	50 ETB/KWh



Note: (1) Potential water supply does not necessarily mean the optimal supply, Farmers could reach the optimal before fully using the potential water supply

Note – Depends on Water Availability

There is significant opportunity to increase incomes by increasing the volume of water irrigated on all sites to optimal levels

Impact on Weekly Farmer Net Profit by Site of Increasing Water Supply, *ETB k*

Assumed Energy Tariff of 13 ETB/Kwh

	Current Practices									Optimal Water Supply					
	Diesel - *75% uptime*				Electric - *100% uptime*										
	Water Pumped *(K m^3)*	Profit Before Pumping*(K)*	Opex Costs *(K)*	Net Profit *(K)*	Water Pumped *(K m^3)*	Profit Before Pumping*(K)*	Opex Costs *(K)*	Net Profit *(K)*	Difference in Profit *(K)*	Water Pumped	Profit before Pumping	Opex Costs (K)	Net Profit (K)	Difference in Profit vs Current	Breakeven Electricity Tariff ETB/KWh *(USD/KWh)*[1]
Lelicho	0.1	5.2	0.7	***4.5***	0.1	5.5	0.3	***5.2***	***+0.7 +16%***	0.2	8.1	0.9	***7.1***	***+2.6 +58%***	***50*** *(1.11)*
Murche	0.1	2.4	0.8	***1.6***	0.2	3.1	0.8	***2.3***	***+1.4 +42%***	0.3	6.4	1.1	***5.3***	**+3.7 +232%**	**57** *(1.27)*
Huluku	0.3	3.0	0.8	***2.2***	0.6	3.7	0.5	***3.1***	***+0.9 +41%***	*0.4*	*3.7*	*0.3*	***3.4***	**+1.2 +155%**	**63** *(1.40)*
Telifa	0.2	4.0	0.5	***3.4***	0.4	4.7	0.4	***4.4***	***+1 +29%***	*0.4*	*6.9*	*0.4*	***6.6***	**+3.2 +94%**	**127** *(2.28)*
Aregawi[2]	0.1	2.6	0.2	***2.4***	0.1	2.8	0.1	***2.8***	***+0.4 +17%***	*0.5*	*6.9*	*0.4*	***6.5***	**+4.1 +171%**	**153** *(3.40)*
Andega	0.1	1.1	0.3	***0.8***	0.2	1.3	0.2	***1.2***	***+0.4 +50%***	*0.2*	*1.3*	*0.2*	***1.2***	**+0.4 +50%**	**61** *(1.35)*
Chefe Kora	0.1	1.2	0.2	***1.0***	0.2	1.7	0.2	***1.5***	***+0.5 +50%***	*0.2*	*2.4*	*0.2*	***2.3***	**+1.3 +130%**	**121** *(2.69)*
Telbo	0.2	2.7	0.7	***2.0***	0.5	3.2	0.5	***2.7***	***+0.7 +35%***	*0.5*	*4.7*	*0.5*	***4.2***	**+2.2 +110%**	**69** *(1.53)*

Note: (1) 1 USD = 45.05 ETB (2) Aregawi site only has one cycle for tomato production due to limited irrigation volume for diesel-based irrigation, electrified irrigation creates the opportunity for a 2nd irrigation cycle

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