SIMULATIONS

What-If SAVi Simulations on a Sustainable Recovery 2020

Why Investing in Water-Efficient Irrigation Is a Pragmatic Recovery Plan for Rural Communities in Ghana

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The Rationale for the What-If Sustainable Asset Valuation (SAVi) Simulations

Planning a sustainable recovery requires that we look ahead and forecast how spending today will play out in the national and global economy in the years to come. It is also important that the ongoing, unprecedented wave of public spending triggers a sustainable recovery, one that has the environment, climate, and social cohesion at its core. The Sustainable Asset Valuation (SAVi) What-If simulations are designed to inform this debate by helping us understand the economic and societal benefits that can be realized when public spending is targeted at sustainable infrastructure. Simulations are inspired by ongoing recovery plans and are based on authoritative data and real science.

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Section 1. About This What-If Simulation

This simulation estimates the additional costs and societal benefits from investing in drip irrigation infrastructure for a rural community in Ghana to assess if such infrastructure could be targeted by sustainable recovery financing. To do so, we draw from preliminary work and simulations undertaken with the Green Climate Fund (GCF). We explored whether drip irrigation could be considered by the GCF for (concessional) financing and/or other financial and non-financial support measures in the context of sustainable and climate-resilient communities. This simulation hence assesses if water-efficient irrigation on 1,010 hectares (ha) of agricultural land in a rural area in Ghana is a worthwhile infrastructure component for sustainable community development in light of climate change and the economic challenges posed by the COVID-19 pandemic.

In recent decades, climate change has led to reductions in annual rainfall in Ghana (World Bank, 2020). This trend is anticipated to lead to water scarcity in the future and will put crop production at risk. Investments in water-efficient irrigation today have the potential to safeguard and even expand crop production. Moreover, such investments could support the effectiveness and co-benefits of other sustainable community development interventions, such as for crop production, that were assessed in further SAVi What-If simulations. Two of these are the main impacts of efficient irrigation: (i) an increase in soil productivity, providing the correct amount of water and avoiding droughts, and (ii) because water-efficient irrigation infrastructure reduces irrigation water requirements, it could expand the area of irrigated land and increase land productivity and production while still using less water than flood irrigation

Section 2. The SAVi Simulation Results

Overview

This SAVi assessment consists of:

- A valuation of the additional costs and benefits associated with the implementation of water-efficient irrigation infrastructure in the proposed project area in Ghana.

It is assumed that water-efficient irrigation will lead to a greater availability of water and free up more land to be used for crop production. Additional project assumptions are as follows:

- Drip irrigation systems will be installed on 1,010 ha of agricultural land, which makes up 50% of the agricultural land in the project area.
- The remaining 1,010 ha of land used for agricultural purposes will continue to use the flood irrigation systems currently in place.
- The water-efficient drip irrigation intervention will enable the conversion of additional land to agricultural land producing rice and maize in equal amounts. This will increase yields, and as a result, revenues—and hence profits—from both crops.
- A project timeline of 30 years.

Table 1 presents an overview of additional costs and benefits of water-efficient irrigation infrastructure when compared to flood irrigation. These are the costs and benefits considered in the calculations of this simulation.

Table 1. Additional costs and benefits of water-efficient irrigation

Additional costs	• Capital costs of replacing flood irrigation systems with drip irrigation infrastructure. • Higher operation and maintenance (O&M) costs associated with drip irrigation infrastructure compared to flood irrigation systems.
Additional benefits	• Profits to farmers from increased rice and maize yields. • Salaries from additional employment opportunities provided by newly cultivated agricultural land.

Table 2 provides an overview of the SAVi What-If simulation results for the first five years of the project. Replacing 50% of existing flood irrigation systems with drip irrigation infrastructure will entail high capital costs significantly higher than additional profits or additional salaries generated in the short term. The net societal results of the project are negative and indicate that the investment will not be paid back within five years even if co-benefits are integrated into the cost-benefit analysis.

Table 3 presents results for a 30-year timespan. The results over the 30-year project lifetime suggest that drip irrigation will require an additional USD 8.47 million in cumulative costs, while the additional profits generated lag slightly over the same period, amounting to USD 8.26 million. The net results for the project owner are still negative in the long term, amounting to a net loss of USD 211,000. However, from a societal perspective, the additional salary creation from increased employment should be integrated into a holistic cost-benefit analysis. The additional salary amount of more than USD 6.38 million causes the overall benefits to outweigh the additional infrastructure costs. The net societal results amount to more than USD 6.6 million by the end of the 30-year project lifetime.

In summary, the high initial capital costs for drip irrigation infrastructure take a considerable amount of time to be compensated by the caused benefits. In fact, the cost-benefit analysis based on this SAVi What-If simulation underscores that, even in the long term, the investments pay off only when the additional salaries generated are considered. From a project owner's point of view—one who benefits directly only from the additional profits generated and who will also have to bear the additional cost of capital (such as interest to be paid for lending over a long time horizon)—drip irrigation infrastructure does not present a convincing investment case. This insight, combined with the fact that drip irrigation infrastructure yields climate change adaptation benefits as well as additional income benefits for rural communities, suggests that public funds such as the GCF are well placed to provide sustainable recovery financing. This would be essential for unlocking the medium- to long-term benefits of the project and realizing the economic feasibility of other such investments. Such sustainable recovery financing can, for example, be realized by providing grants to cover part of the capital costs or to provide concessional lending to lower the cost of capital for agricultural project owners. Providing such financing solutions can also crowd-in commercial lenders and other private investors, enabling the financing of drip irrigation infrastructure and the realization of economies of scale and wider-spread community development benefits.

Table 2. Overview of SAVi simulation short-term results (USD)

Cumulative results for water-efficient irrigation over five-year project timeline	**Cumulative value after five years (USD)**
Cost and benefit positions	
(A) Total additional costs of replacing 50% of flood irrigation systems with drip irrigation	7,110,000
(B) Total additional profits from improved agriculture yields	1,377,000
Net result (B)-(A)	**(5,733,000)**
(C) Additional salary from employment creation	1,139,000
Net societal result from water-efficient irrigation (B)+(C)-(A)	**(4,594,000)**

Table 3. Overview of SAVi simulation long-term results (USD)

Cumulative results for water-efficient irrigation over 30-year project timeline	**Cumulative value after 30 years (USD)**
Cost and benefit positions	
(A) Total additional costs of replacing 50% of flood irrigation systems with drip irrigation	8,472,000
(B) Total additional profits from improved agriculture yields	8,261,000
Net result (B)-(A)	**(211,000)**
(C) Additional salary from employment creation	6,834,000
Net societal result from water-efficient irrigation (B)+(C)-(A)	**6,623,000**

A Closer Look at the Simulation for Water-Efficient Irrigation

Table 4 presents the short-term results of the What-If simulation; Table 5 highlights the long-term results.

First, the total additional costs presented in Table 4 correspond to the additional investment required for transitioning from flood-based irrigation to more water-efficient drip irrigation. Implementing more efficient irrigation systems is projected to cost USD 6.838 million in additional capital investment and USD 272,000 in O&M costs in the first five years of implementation. These O&M costs amount to USD 1.8 million over the 30-year project timeline.

Second, the implementation of drip irrigation infrastructure to replace 50% of the currently used flood irrigation systems in the project area has the potential to reduce annual water demand by more than 1,1 million m3, which adds up to over 30 million m3 in water saved over the 30-year project timeline. This will enable the rural community to irrigate and cultivate an estimated 1,275 ha of new agricultural land to produce more maize and rice compared to the status quo. The additional profits that can be generated by this additional agricultural land total USD 8.26 million over the 30-year project timeline.

Finally, the additional 1,275 hectares of land cultivated for maize and rice production will create additional employment and hence provide salaries for employees. Over the 30-year timeline, this amounts to more than USD 6.83 million in additional labour income.

We note in Table 5 that investments in water-efficient drip irrigation infrastructure will lead to net societal benefits of more than USD 6.6 million by the end of the 30-year project timeline. This suggests that, despite its high capital costs compared to flood irrigation, investments in water-efficient drip irrigation are attractive in the long term from a societal point of view. However, from the point of view of a project owner, who benefits directly only from the additional agriculture profits generated, drip irrigation infrastructure does not present a convincing investment case. This is evidenced by the negative net result in Table 5. Considering that a project owner must also bear the additional cost of capital for lending enough to cover the high capital costs of drip irrigation infrastructure (and will likely face a long payback period), the project might not be bankable. Commercial lenders might in fact not offer attractive lending terms or might show no interest at all in lending.

Given the estimated income benefits and the fact that water-efficient irrigation infrastructure will help the rural community in Ghana avoid potential future water scarcity issues resulting from projected climate change, this still presents an essential investment for sustainable community development. Therefore, public funds such as the GCF are well placed to provide sustainable recovery financing, in the form of grants and/or concessional lending, to crowd-in commercial lenders and other private investors. This would unlock the benefit potential of implementing drip irrigation infrastructure in rural settings.

Table 4. Short-term results of the What-If simulation for water-efficient irrigation (USD)

Cumulative results for water-efficient irrigation over five-year project timeline	**Cumulative value after five years (USD)**
Cost and benefit positions	
Additional capital costs of replacing 50% of flood irrigation systems with drip irrigation	6,838,000
Additional O&M costs of 50% drip irrigation and 50% flood irrigation compared to 100% flood irrigation	272,000
(A) Total additional costs of replacing 50% of flood irrigation systems with drip irrigation	7,110,000
Profits from additional maize yields	457,000
Profits from additional rice yields	920,000
(B) Total additional profits from improved agriculture yields	1,377,000
Net result (B)-(A)	**(5,733,000)**
(C) Additional salary from employment creation	1,139,000
Net societal result from water-efficient irrigation (B)+(C)-(A)	**(4.594,000)**

Table 5. Long-term results of the What-If simulation for water-efficient irrigation (USD)

Cumulative results for water-efficient irrigation over 30-year project timeline	**Cumulative value after 30 years (USD)**
Cost and benefit positions	
Additional capital costs of replacing 50% of flood irrigation systems with drip irrigation	6,838,000
Additional O&M costs of 50% drip irrigation and 50% flood irrigation compared to 100% flood irrigation	1,634,000
(A) Total additional costs of replacing 50% of flood irrigation systems with drip irrigation	**8,472,000**
Profits from additional maize yields	2,740,000
Profits from additional rice yields	5,521,000
(B) Total additional profits from improved agriculture yields	8,261,000
Net result (B)-(A)	(211,000)
(C) Additional salary from employment creation	6,834,000
Net societal result from water-efficient irrigation (B)+(C)-(A)	**6,623,000**

Section 3. Using the Results of This Simulation

This SAVi What-If simulation on drip irrigation infrastructure offers two key insights. First, investing in water-efficient irrigation triggers multiple benefits, making the investment worthwhile from a societal point of view. The climate change adaptation benefits of drip irrigation also need to be stressed. Investing in drip irrigation infrastructure would contribute to sustainable community development, making it an appealing option to meet the sustainable recovery ambitions of rural communities that face intensified economic challenges in the aftermath of the COVID-19 pandemic.

Second, the high capital costs—along with the anticipated high cost of long-term lending in developing countries like Ghana—might actually mean that such projects are not financially feasible under commercial market conditions. It is hence crucial to draw the attention of public funders and donors to such projects, especially during the COVID-19 pandemic where recovery spending is made available domestically and internationally. Grants, concessional lending, or guarantees could be provided by public institutions to cover part of the capital cost, decrease the cost of financing, and crowd-in commercial lenders and private investors.

Section 4: The Design of the Simulation

Table 6. Simulation details

Indicator	Explanation
Additional capital cost of replacing 50% of flood irrigation systems with drip irrigation	This simulation assumes that the implementation of this project will reduce annual water demand by 1,100,854 m3, a total of 11,922,254 m3 in the 30-year lifespan of the project. This has the potential to free up 1,275 ha of agricultural land for more production. Capital cost and O&M cost estimates use assumptions from O'Brien et al. (2011). An estimate of USD 81.5/ha was assumed for flood irrigation implementation and USD 3,229.7/ ha for drip irrigation. In addition, O&M costs are estimated at 3% of CAPEX based on O'Brien et al. (2011), and irrigation efficiency of 25% for flood irrigation and 64% for drip irrigation were used in the calculations based on Sauer et al. (2010).
Additional O&M costs of 50% drip irrigation and 50% flood irrigation compared to 100% flood irrigation	
Profits from additional rice yields	The value of additional rice production was calculated assuming 1.68 tons of rice are produced per hectare per year, as estimated by the Global Yield Gap Atlas (2012). The total additional amount of rice produced assumes 556 of the 1,275 hectares of new agricultural land is used for rice production. This leads to an additional 37,080 tons of rice produced during the 30-year lifetime of the investment. Additional revenue for the 33,420 tons of additional rice produced totals USD 110,422,560. Assuming a 5% profit share, the profits generated from the additional rice revenues total USD 5,521,128 by the end of the 30-year investment.
Profits from additional maize yields	The value of additional maize production was calculated assuming 1.68 tons of maize are produced per hectare per year, as estimated by Global Yield Gap Atlas (2012). The total additional amount of maize produced assumes 556 of the 1,275 hectares of new agricultural land is used for maize production. This leads to an additional 37,080 tons of maize produced during the 30-year lifetime of the investment. Additional revenue assumes local market prices for maize. Additional revenue for the 37,080 tons of additional maize produced totals USD 54,805,650. Assuming a 5% profit share, the profits generated from the additional maize revenues total USD 2,740,283 by the end of the 30-year investment.
Salary creation from additional employment opportunities	Average employment of 0.3 people per hectare was assumed for this simulation. Considering the estimated 1,275 ha of additional agricultural land freed up from increased water availability, an additional 383 jobs can be created annually. These total 11,490 new jobs over the project lifetime. Considering the estimated average salary for an agricultural worker of 3,420 GHS/Person/year as estimated by SalaryExplorer (2020), the total additional labour income from implementation of the water-efficient irrigation system is USD 6,834,052.

References

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About SAVi

The SAVi is a simulation service that helps governments and investors value the many risks and externalities that affect the performance of infrastructure projects. It integrates best-in-class climate data from the EU Copernicus Climate Data Store.

The distinctive features of SAVi are:

- Valuation: SAVi values, in financial terms, the material environmental, social, and economic risks and externalities of infrastructure projects. These variables are ignored in traditional financial analyses.
- Simulation: SAVi combines the results of systems thinking and system dynamics simulation with project finance modelling. We engage with asset owners to identify the risks material to their infrastructure projects and then design appropriate simulation scenarios.
- Customization: SAVi is customized to individual infrastructure projects.

Check out the SAVi track record, on-line demo, and academy at www.iisd.org/savi.