

# EFFICIENCY FOR ACCESS RESEARCH AND DEVELOPMENT FUND: INNOVATOR SERIES

## Developing a highly efficient, solar-powered mill for commercial use



People living in rural areas of sub-Saharan Africa are usually subsistence, smallholder farmers who consume their own produce and may sell any remaining goods. Small agricultural businesses grow and harvest food crops such as cassava, maize, millet and sorghum, that requires processing before consumption.

There are limited options for providing milling services in off-grid, rural areas. Manual milling processing or technologies powered by diesel are the only options for milling in these communities. Diesel-powered mills provide an essential service to the agriculture business, but they also create problems. Diesel milling systems are expensive, large, noisy, polluting and inefficient. They lower the quality of the product by mixing mould flecks in the grains.

Diesel mills are not socially inclusive for rural residence and those of lower income backgrounds. As the price of diesel increases so does the price of produce for poor communities, risking their access to food. Diesel mills are usually located in town centres, far away from small farms in rural regions.

It is often the responsibility of women in the community to travel long distances, typically involving walking, and carrying the sacks of grains to milling centres, then waiting a minimum of around 30-60 minutes to mill the grains.

Existing technologies available to the market are not economically, environmentally, and socially inclusive, requiring innovation to solve the issues related to diesel milling solutions. Since 2019 Agsol has been focused on this challenge, moving beyond simply solarising the technology alone to address all the challenges related to current milling solutions. Instead, they have focused on developing a small, efficient, and affordable solar-powered mill that can out-compete diesel mills on price and profitability.

### DID YOU KNOW?

**Across Sub-Saharan Africa, women waste an average of 40 billion hours travelling to mills<sup>1</sup>.**

<sup>1</sup> [Improving Communities and Women's Lives with Solar Mills in Nigeria, September 2024](#)

## AGSOL LIMITED

Established in 2016, Agsol was set up to develop a solar-powered milling machine for small farming communities, to reduce manual labour, improve economic opportunity and enable access to higher-tier energy services in rural regions of sub-Saharan Africa.

Agsol has established a base in Kenya to concentrate on the East African market and to develop custom milling technology for grains. Agsol has spent the last four years on product development and testing with the quest to develop a viable solar milling solution.

The Efficiency for Access Research and Development Fund enabled Agsol to develop the 'MicroMill' which aimed to be two-three times more efficient than any other small electric mill.



A woman miller in Kinakoni using the Agsol solar mill.



A shop owner in Ikandani showing their business licence for the use of the Agsol solar mill.

### Agsol

“This project has enabled the development of the most efficient, smart and affordable grain mill ever. The MicroMill outperforms a diesel mill to such a degree that diesel mills will soon be a thing of the past.”

**Matt Carr - CEO & Co-founder of Agsol Limited**

### How the Efficiency for Access Research and Development Fund supported Agsol

Building on the success of its MicroMill v1, which validated demand for affordable and efficient milling technology, Agsol advanced to the MicroMill v2 with additional funding from Efficiency for Access. As the world’s most energy and cost-efficient electric mill, this innovation can help improve transform food processing for over half a billion people in rural sub-Saharan Africa. The refined MicroMill v2 introduces three industry-first features that set new standards in milling technology.

### Custom-Built Brushless DC (BLDC) Motor

The MicroMill required a specialised motor for direct drive, highly efficient milling, as no suitable option existed on the market. To meet this need, Agsol designed a custom BLDC motor optimised for solar power, capable of performing at high speeds, water- and dust-resistant, and built to withstand intense vibrations.

Agsol implemented the custom-built BLDC motor paired with power electronics and intelligent firmware, ensuring the mill operates at peak performance while protecting the system.

### Increasing Machine Efficiency

The MicroMill’s efficiency rose from 58 to 75 kg/kWh, representing a 29% improvement, exceeding Agsol’s 20% target by 50%. This gain was driven by a more powerful motor and a refined feed control mechanism.

**Reducing product costs to improve affordability**

Agsol successfully reduced the MicroMill’s material costs by 44%, from USD 285 to USD 160, more than double the target of a 20% reduction. This was achieved by decreasing the mill’s weight from 13kg to 7kg, and its volume from 0.06m<sup>3</sup> to 0.02m<sup>3</sup>. To achieve these goals, Agsol streamlined fabrication and developed a custom, lower-cost BLDC motor driver, eliminating the need for a more expensive purchased model. Although the motor cost increased from USD 40 for the 400W off-the-shelf motor, to USD 60 for Agsol’s custom 800W version, the fully solar-powered MicroMill saw a retail price drop from USD 2000 down to USD 1300, reducing the total production cost by 35%.



**Primary school students in Kinakoni with the Agsol solar mill.**

**Enabling interoperability with Off-Grid Appliances and PAYGo Platforms**

The MicroMill is designed to run on a 48V DC supply, optimised for solar power. However, it can also be powered from the grid or mini-grid with an AC-DC power converter. Agsol developed systems that allow the MicroMill to function in weak-grid areas, offering options for AC with battery backup or a full hybrid solar-AC setup.

Agsol has also explored innovative power solutions, including using e-bikes. In collaboration with a leading e-bike company, they tested how long a battery could power the mill. The results showed that a single battery could run the mill for up to four hours after a 50km ride.

The MicroMill’s battery includes a 12V power outlet and programmable charging circuit, enabling users to power 12V and 5V appliances. However, a key challenge is that mills are often located far from homes, making it difficult for users to access this power for household appliances.

As part of its second project with the Efficiency for Access Research and Development Fund, Agsol aimed to implement a PayGo financing system. While Agsol couldn’t complete this during the project, it is actively designing it for the next version of the MicroMill. Developing and testing a PayGo financing system for this technology is complex, so Agsol has selected five of its gold MicroMills for consumer financing pilots, which they plan to launch later this year.

**KEY INSIGHTS AND LEARNINGS**

**Diesel mill vs. Agsol’s MicroMill**

Agsol’s solar-powered MicroMill outperformed diesel mills on key performance indicators, including retail price, operating costs, maintenance, profitability, ease of use, flour quality, gender inclusivity, portability, installation, and carbon footprint. Although the MicroMill mills at 60kg/hr (compared to 120kg/hr for diesel mills), rural diesel mills typically process only 110kg/day, with delays between each use.

Agsol’s research and development identified a 25-30% reduction in the bill of materials (BOM), which would make the MicroMill more affordable than diesel mills. This has the potential to revolutionise the industry. Solar-powered mills are typically more costly than fossil fuel alternatives, and could establish a pathway for affordable, sustainable milling solutions for off-grid regions.

The original MicroMill had a 400W motor, while the new version has an 800W motor. Agsol’s research revealed that both motors lost around 200W of electricity when idle. The second version is more efficient, using 600W for milling compared to the MicroMill v1, which uses 200W.

Rural diesel millers operate on slim margins, with over 40% of revenue spent on fuel, oil and maintenance. In contrast, less than 1% of the MicroMill’s revenue goes toward its power generating system, making it nearly 70% more profitable per unit of flour produced.

**PROJECT CHALLENGES**

Agsol faced several challenges during this project, primarily due to the COVID-19 lockdowns in China and Kenya. These restrictions caused shipping delays and component shortages, disrupting the project timeline.

As Agsol prepares for its next manufacturing run, it plans to engage more directly with vendors and explore setting up a manufacturing station in India.

Another challenge was identifying and understanding customer segments to better inform product development. Agsol aims to create an onboarding data logger to capture user data, which would help fill gaps in their impact reports. Although [60 Decibels](#) conducted a comprehensive consumer impact report, the lack of direct customer data limited the depth of analysis.

### Impact analysis

Conducting an impact analysis for milling solutions is complex due to the diversity of products and different consumer segments. Factors like whether customers are buying a solar-powered or grid-powered mill, and their motivations for purchasing, can vary widely. This made it challenging for Agsol to provide a consumer impact analysis that would resonate with external audiences. However, the report that Agsol conducted with 60 Decibels was able to capture broad customer experience metrics, and provide valuable insights that more specific questions might have missed.

### Environmental impact

A key motive for this project was to reduce the carbon footprint of milling by replacing diesel-powered mills with off-grid, solar-powered alternatives that are more affordable.

Out of the 83 mills deployed during the project, 26 were sold as full solar setups (including solar panels, battery and the mill), 27 were sold as mills only to solar distributors, and 30 were sold in AC format.

Solar-powered mills are not only more environmentally friendly than diesel mills, but consumers have also reported better flour quality, cleaner tasting grains, and a lack of black mould.

### NEXT STEPS

As of early 2023, Agsol is focused on developing reliable manufacturing capabilities with plans to explore mass production and improve key components like the milling head. China remains a potential opportunity as well. Their goal is to reach a production capacity of 500 mills per month from 2024.

Agsol has received strong customer feedback, including a high Net Promotor Score, with 83% of customers agreeing that the MicroMill is a solid business investment. They will continue to develop a PayGo financing plan to expand access and attract a broader customer base.

### GET IN TOUCH

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