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EFFICIENCY FOR ACCESS RESEARCH AND DEVELOPMENT FUND: INNOVATOR SERIES

ARE SOLAR-POWERED MICRO MILLS THE KEY TO AFFORDABLE AND EFFICIENT GRAIN PROCESSING?

People living in rural sub-Saharan Africa are often smallholder farmers and subsist on the food they grow. In East Africa, maize, millet, sorghum, and cassava are the most important staple food crops for smallholder farmers and all require processing before they can be eaten. Every day, women and girls living in off-grid households around the world spend 250 million hours processing essential staple foods to feed their families, often travelling long distances to milling stations.

Options to process staple foods in off-grid areas are limited. Apart from tedious hand processing, the go-to option is diesel milling technology. Diesel mills provide an essential service to rural people and there are approximately 800,000 machines in East Africa alone. However, because they are large, inefficient, and expensive to operate, they only make sense in larger communities where there are enough customers to use them. This means people living in smaller or dispersed communities experience hardship in accessing these essential services. As a result, women must spend many hours each week walking to diesel mills. Once they get there, they must often wait further until enough customers queue up to warrant the miller starting up the inefficient machine. Additionally, diesel mills are polluting, and the flour they produce has a distinct and unpleasant diesel flavour.

Solar milling can help change how essential milling services are delivered in rural areas. Small, efficient, and affordable solar-powered mills that can out-compete diesel mills on price and profitability are one solution. Small or micro milling machines can create a highly decentralised network of essential milling services and are a viable option for small-holder farmers. They have the potential to increase rural productivity, generate income and offset the time spent travelling to and waiting for large diesel mills.

Despite the market opportunity, attempts to develop a viable technology in recent years have been unsuccessful. This is because 'solarising' currently available milling technologies do not constitute a viable solution because of their inherent inefficiencies, meaning a solution is too expensive, too slow or both.

DID YOU KNOW?

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AGSOL'S MICROMILL: THE KEY TO AFFORDABLE AND EFFICIENCT MILLING

Agsol was established in 2016 to develop solar powered milling machines that can viably serve small communities, improve labour efficiencies, keep more money in rural economies, and catalyse access to higher tier energy services. The company has its operational base in Kenya and a facility in China where primary product research and development (R&D) happens.

AGSOL:

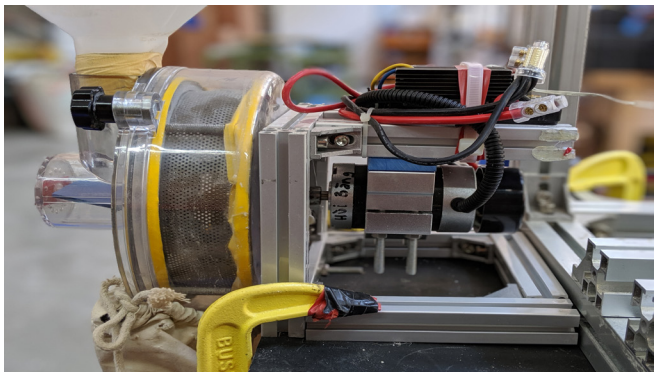
The Efficiency for Access Research and Development Fund's financial assistance was critical in supporting Agsol to make a viable solar milling solution. The R&D work carried out under this project has helped Agsol create the most efficient small grain mill we know of in the market. An efficient mill means that a smaller and more affordable solar system is needed to power the appliance.
– Matt Carr, CEO and Co-founder, Agsol

HOW DOES IT WORK?

Agsol developed the 'MicroMill', which aimed to be two – three times more efficient than other small electric mills. The starting point for the project was to identify a suitable direct drive brushless DC (BLDC) motor. The rationale for a direct drive motor is that it is the most efficient and cost-effective approach to transfer electrons to shaft power, as there are no transfer losses or additional components.

More than 15 BLDC motors were extensively tested for their potential to power a high-speed direct drive milling machine. Motors were assessed using a variety of endurance and destructive testing procedures at Agsol's R&D facility in China. Agsol built a custom test bed that monitored and logged all vital motor diagnostics during these tests. Based upon the results, a 400W high speed BLDC motor was selected to take forward.

Agsol successfully developed a super-efficient, smart, and comparatively affordable solar milling solution. Despite this, the MicroMill developed under this project was considered unfit for market because the speed of the mill was deemed too slow by customers, and the motor ultimately experienced failures during extended field tests.



WHAT DID WE LEARN?

Extensive project testing is needed to reach a viable milling solution.

Although the MicroMill was efficient and reasonably priced, the milling speed created frustrations for owners and customers. Based on conversations and surveys with MicroMill owners, Agsol concluded that a viable solution should produce twice as much grain as Version 1 MicroMill, equivalent to 50kg/hr, and that it should be the same price or cheaper than a new diesel mill. These learnings establish important reference points to work towards and shape future product development.

Motors must have a unique set of specifications for small-scale milling.

Agsol found it very difficult to source or find a suitable motor for the MicroMill. The company initially assumed that with the abundance of electric motors and suppliers in the market, it would not be difficult to source a suitable motor for small-scale milling. However, this was not the case.

Agsol sourced a selection of custom motors and off-the-shelf motors from different suppliers that met the approximate power and speed requirements they needed. However, with all the motors, they experienced unacceptable failure rates in early laboratory testing. As a result, Agsol opted for mass-produced motors, which was ultimately a compromise on the desired specifications.

Early in the field pilot and through informal interactions and structured focus groups, it was clear the selected motor was underpowered and too slow. Unfortunately, Agsol could not find an off-the-shelf motor that met the necessary requirements in terms of speed, power, robustness, and affordability for small-scale direct-drive milling.

These findings highlight the unique specifications that a direct drive motor needs for small scale milling applications. The stresses put on a motor in pulverising hard grains to flour, along with the occasional stone or piece of metal, are exceptional compared to the stresses placed on other small electrical appliances. Small, direct drive milling presents an entirely new use case for BLDC motors.

Customer prospecting is vital to ensure a viable business.

An important challenge in making the business case work for a mill owner is understanding whether they can attract enough end-user customers. This is particularly important if the system is sold under finance and mill revenues are required to make re-payments.

A solar milling site has to offer a 'convenience factor' for the end-user and will have the best chance of maximising revenues when there is a favourable combination of factors. These include being off-grid, located far from competing mills, and having a captured customer base in proximity that needs milling services. However, the pilot also highlighted other factors such as natural flow of foot-traffic, proximity to other community sites (markets, churches, schools) and more nuanced factors, such as business acumen and the person's reputation within the community.

Typical customer prospecting approaches and tools for consumer financing products are insufficient in assessing a potential solar milling customer. This is further complicated as the MicroMill targets customers who are non-traditional millers and an element of behaviour change is necessary compared to diesel mills to increase demand during daylight hours.

To scale solar milling technologies, new tools and processes need to be developed to efficiently prospect and score consumer finance customers. There will also need to be a degree of market activation and time to stimulate the market.

THE MARKET OPPORTUNITY FOR OFF-GRID MILLING SERVICES

The field pilot showed that a large market exists for improved off-grid milling services. Although a diesel mill is the main technology used in the market, it is also the only solution commercially available in the market.

Most rural diesel millers operate highly marginal businesses. Agsol's market analysis suggests 38% of revenues generated at diesel mills are spent on fuel, oil, and regular engine servicing. In contrast, the solar MicroMill has less than 1% of revenue spent of the power generating system. That means, per unit of flour milled, a solar mill is more than 50% more profitable than diesel mills.

Agsol learned from interactions with MicroMill owners and end users that the MicroMill should be twice as fast and have a retail price that is equal or lower compared to a new diesel mill. Equipped with this knowledge, Agsol has begun working on its v2 MicroMill. To achieve the increase in production speed, Agsol has designed its own custom BLDC motor for the unique use case of direct drive small scale milling.

Agsol's new, custom BLDC motor in v2 is twice as powerful as v1 and lab testing shows a production rate has nearly tripled, indicating a further increase in efficiency. In v2, Agsol has improved the auto-feeder mechanism, integrated the electronics into the mill, halved the mills size and thus the materials required, simplified the design, resulting in 60% reduction in costs. The first market trials of the v2 MicroMill will begin in August 2021.

GET IN TOUCH:

EforAgrants@est.org.uk