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EFFICIENCY FOR ACCESS RESEARCH AND DEVELOPMENT FUND: INNOVATOR SERIES

OFF-GRID COLD ROOMS: A GAME-CHANGING DEVELOPMENT FOR LOCAL SMALLHOLDER FARMERS

Globally, 1.3 billion tonnes of food are wasted or lost per year. Post-harvest food loss threatens food security, farmers' livelihoods, and the environment. CO_2 emissions from global food loss and wastage are estimated to be 4.4 billion tonnes each year, or 6 – 10% of overall greenhouse gas emissions. Most of these emissions are from methane gas generated in landfills, caused by food waste decomposing.

Cold rooms – refrigerated spaces with controlled temperatures – can help to reduce these losses and offer other benefits. Multiple power sources across grid electricity, solar systems, or diesel generators can power them. A typical commercial off-grid cold room consists of a solar array, remote monitoring, a battery and/or thermal storage, a cooling unit and insulation materials.

However, a cold room can be an energy-intensive and expensive technology that requires a reliable electricity supply. Their capital and running costs are generally too high for smallholder farmers. As a result, in Sub-Saharan Africa, farmers typically rely on basic, non-mechanical cooling technologies, such as charcoal coolers, night air ventilation, and brick and mortar storage rooms.

DID YOU KNOW?

Food loss reduces the income of 470 million smallholder farmers and downstream value chain actors by at least 15%.

SMART VILLAGES RESEARCH GROUP: FINDING INNOVATIVE SOLUTIONS TO SUPPORT RURAL SMALLHOLDER FARMERS

Smart Villages Research Group (SVRG) is a non-profit organisation based in the UK that specialises in finding innovative solutions for integrated development. SVRG creates solutions that combine different technologies and business models to address the priorities of local community in a sustainable and affordable way.

For this project, SVRG partnered with EcoLife in Uganda, a social enterprise researching innovative technologies to support rural smallholder farmers with sustainable agricultural production.

SVRG :

"Trying to design a solution that achieves a sophisticated outcome using low-technology components is a high-risk venture – especially during a global pandemic. Without the support and patience of the Efficiency for Access Research and Development Fund, SVRG and EcoLife would never have been able to achieve this amazing result for rural farming communities in the developing world."

– Dr Bernie Jones, Managing Director, Smart Villages Research Group

PILOT COLD ROOM MADE WITH LOCALLY APPROPRIATE MATERIALS AND EQUIPMENT

The Efficiency for Access Research and Development Fund supported SVRG to create a pilot cold room, suitable for off-grid use, which would be affordable and accessible for smallholder farmers in Uganda. The company researched various local materials for cold construction and based its pilot cold room on the cost, availability, thermal performance, and durability of the materials. SVRG chose a design that could be assembled locally to reduce transport costs, create more efficient production lines, and increase local employment.

The pilot cold room comprised:

Cavity walling material made from compressed soil blocks (interlocking stabilised soil blocks (ISSBs)). The soil blocks comprise local sub-soil, sand and 5 – 7% cement. SVRG chose this material, as it offered many benefits. Only the cement needs to be bought and transported to the building site, reducing the cost of transport and the emissions from vehicles. Moreover, very little cement is needed to build the blocks, further reducing transport coss. The blocks also have excellent thermal characteristics, making the cold room more efficient. Lastly, sub-soil and sand can be collected by local communities, creating employment.

Cavity wall and roof insulation material made from rice husk. Rice husk is typically discarded, as it is a waste material, so it is a readily available resource. It does not degrade quickly as it has high silicate content, has an excellent thermal performance for insulation and is easy to use.

Air conditioning units. SVRG researched alternative chilling technologies, selecting locally available, single-phase split-unit LG air-conditioning units, which it modified to achieve lower temperatures. SVRG chose the LG units as they are widely available from local retailers and have many benefits. The units have a high-quality inverter technology that is suitable for off-grid solar energy systems. They are easy to install and maintain locally, have a relatively low cost (<£1000/unit), and do produce excess ice, even when producing low temperatures, meaning they are suitable for food storage. The units also have low electrical ratings and consumption (2.5kW at peak usage, and <12kWh/day in normal running), which helps to keep costs down. Real-life performance was comparatively much lower than this, around 0.5kWh, and operating at 1kW during the cooling cycle.

PILOT COLD ROOM CONSTRUCTION

SVRG researched optimal construction methodology by measuring the cooling and insulating performance of a pilot cold room, built with ISSBs, rice husks and the LG air-conditioning units. It checked for any hot spots using thermal imagers and monitored how long the room would maintain temperature without active cooling (a heat gain of ~5°C over 12 hours).

The inner wall of ISSBs had significant thermal mass and provided a thermal reservoir to maintain cold rooms' temperatures for several hours without active cooling. Using a low-cost "water wall", which entailed stacking water-filled plastic jerrycans around the inside wall, provided an even more significant thermal reservoir. With this in place, the cold room warmed by ~2°C per day, without active cooling. The cold room maintained temperatures of 6°C with this approach, perfect for food storage.

SVRG also experimented with dividing the room into several "zones" of different temperatures, by hanging curtains to restrict air circulation and therefore heat flow. Using this partitioning not only created several distinct, stable thermal zones across the room, but also managed to achieve much lower temperatures at the "cold" end, with temperatures at or below 2°C.

Pre-cooling, productive heat, and power utilisation

SVRG also created a passive pre-cooling facility, which helped to increase the efficiency of cold room operations. The facility is able to cool goods at around 6°C below ambient levels before they enter the room, thus saving time and energy. The most cost-effective solution for pre-cooling is an indoor antechamber that has a roof and surrounding walls. This combines the shading effect by harnessing escaping cold air from the cold-chamber door being opened.

Due to the energy efficient cold room, a solar power system smaller than the one SVRG originally installed could be used. Even this system would have the capacity to supply an average of 15kWh of energy each day. At the prices prevalent for electrical services in communities, it would still allow the cold room operators to add revenue of $15 daily to their activities.

WHAT DID WE LEARN?

The benefits of local materials and construction methods

SVRG prioritised local materials and assembly to create a cold room that was more affordable and had benefits for the local community, such as employment. At the beginning of the project, SVRG tested numerous materials such as maize cobs for insulation materials before selecting rice husk as their preferred material. The project showed that that locally available, low-cost and low-tech materials can be successfully used to construct efficient, affordable cold rooms for rural farming populations.

Capacity building with local partners

Although SVRG used local materials and equipment, the cold room adopted methods that local technicians or craftspeople were unfamiliar with. Capacity building from local partners is necessary to ensure optimum outcomes.

The importance of active community engagement

As SVRG focused on local assembly and construction, the company realised the importance of community engagement. There was a need for active engagement from local manufacturers to build the cold room and SVRG helped to spread awareness about the cold room's benefits. It trialled different approaches to encourage local participation in the construction and operation of the cold room. SVRG is also trialling new approaches to suit different communities.

SCALING UP THE CONSTRUCTION OF COLD ROOMS FOR LOCAL FARMING COMMUNITIES

SVRG is using the pilot cold room design as the core of a much larger farmer's enterprise centre, a much larger cold room that multiple smallholder farmers can use. This centre aims to help rural farming communities in Uganda capture more value and profit from their crops. As a result, SVRG has received enquiries from organisations to construct more farmer enterprise centres.

In the next five years, in partnership with EcoLife, SVRG plans to install 100 cold rooms in Uganda, bringing cold rooms and energy access to more than 200,000 people in rural Uganda, and help avoid food-loss and increase

GET IN TOUCH:

EforAgrants@est.org.uk