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Techno-economic evaluation of a solar biomass hybrid flatbed dryer for maize cob drying in Rwanda

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Abstract

Maize is vital for Rwanda's food security, with an average yield of 4.5 tons/ha. However, post-harvest losses remain significant, especially during drying, contributing to around 16 % of total losses. Cooperatives traditionally use aluminium or plastic sheet shelters with wooden frames for drying, but this method has limitations. It takes up to two months and lacks proper storage, leading to spoilage and low-quality end products. Hence, the objective of this study was to assess the economic feasibility of an alternative solution: a solar-biomass hybrid dryer. This dryer, designed to be efficient and sustainable, combines solar energy with biomass to expedite the drying process and address the shortcomings of the traditional method.

The solar-biomass hybrid dryer was constructed at the farmers' cooperative in Twizamure Cyuve, in Musanze, Rwanda. This dryer uses solar energy for generating energy to power its fans and biomass energy as the heat source.

Data on the existing drying methods was collected by interviewing farmers and processors in the maize value chain. Farmers in the cooperative produce an average of 802 kg maize per season.

The average moisture content of fresh maize is 22%, and it falls to <14% after drying, which takes about 4-5 days in the solar-biomass hybrid dryer. This is a rapid drying process for the farmers compared to the current two-month drying period in the shelters. The maize is valued at € 0.19/kg fresh and € 0.295/kg after drying. Drying the maize before selling ensures that the spoilage is minimised. Not only this, it also increases the farmers' revenue.

Two scenarios, contingent upon whether the cooperative decides to buy their members' maize and dry it or offer the dryer as a drying service to famers, were compared. Depending on the type of business model employed, the NPV of the dryer is € 636.18 or € 188.68 and an IRR of 22.21 % or 18.57 % respectively. The payback period for the constructed dryer is either 6.83 years or 6.90 years, both suggesting that the overall investment is economically justified when compared with the 20 years lifespan of the dryer.

The dryer can still be enhanced in various ways. Reducing heat loss through improved insulation, sealing gaps, and optimizing airflow to maintain consistent temperatures is crucial. A robust business model can improve its economic feasibility, including exploring additional revenue streams from neighbouring cooperatives and drying other agricultural products alongside maize. By operating throughout the year and optimizing the use of available energy, the dryer can achieve higher utilization rates and generate more consistent revenue.

Key words:

Resilient food systems, post-harvest losses, drying, economic feasibility, food security, payback period