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Opportunities and challenges for an innovative solar milk cooling system in Zambia: a case study

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Abstract

The low electrification rate in rural regions, the low milk production volumes of smallholder farmers and the changing consumption habits for milk and dairy products suggest potential for small to medium scale solar milk cooling systems in Zambia. The University of Hohenheim and Solar Cooling Engineering UG (Köngen, Germany) have developed a modular solar cooling system. The technology is based on the use of vapor-compression refrigeration units to produce ice, which is then used as a cooling medium. The modular approach enables an adaption of the system to the operators’ needs in terms of capacity and design. This case study examines the economic feasibility of the proposed system for different sizes, as well as characteristics of potential users in terms of milk production and marketing in the Zambian southern province specifically the Zimba region. The economic feasibility was determined for systems with a cooling capacity ranging between 80 and 500 L of milk per day by the calculation of the net present value (NPV) and internal rate of return (IRR). The costs of the potential systems were estimated based on the local assembly in Zambia and were compared to an on-grid solution. Essential data was obtained by conducting interviews with experts in different key positions and a survey among off-grid smallholder farmers without affiliation to dairy cooperatives (mixed methods). The economic feasibility of the systems highly depends on the location and accessibility for off-takers, financing method, margin of the operator as well as the extent of utilisation during dry season, favouring scenarios where no transport of milk from the operators’ side is required. While higher volumes increase the likeliness of milk pick-up by processors, the prices of the higher volumes systems are posing a major challenge. Moreover, a successful implementation is influenced by different contextual production characteristics, like the range of farmers’ individual milking times, as well as milking periods, calving intervals and months in dry season which are intensifying a drop in milk production volumes. This study is an example of the importance of field study before introduction of technological innovations.

Keywords: Dairy smallholder farmers, economic feasibility study, innovations, solar milk cooling, Zambia