INTRODUCTION OF SOLAR POWERED TECHNOLOGIES TO THE SMALLHOLDER DAIRY INDUSTRY IN MALAWI

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Executive Summary

Malawi's dairy industry consists of about 7,000 smallholder farmers who produce the bulk of milk available for processing. These farmers do not have access to electricity or reliable power/energy sources for milking and water supply. Milking is done manually using hands and a majority of the farmers do not have a reliable supply of safe drinking water for cows and for maintaining adequate levels of sanitation. Consequently, the smallholder dairy industry is characterised by low milk production and poor milk quality resulting in huge financial losses. Machine milking can address the two challenges – low milk production and low hygiene – but requires a steady supply of clean water, hence the need for water pumps.

The operation of milking machines and water pumps requires energy which is generally inaccessible to smallholder dairy farmers. As of 2014, access levels to grid electricity in Malawi was lower than 2% in rural areas where smallholder dairy farming is practiced.

Malawi has a high solar energy potential which can be introduced into the country's smallholder dairy industry. The overall objective of this project was to contribute towards improved milk production among smallholder dairy farmers in Malawi through the introduction of two innovative solar powered dairy production technologies (i) solar powered milking machines and (ii) solar powered water supply systems. Both these technologies are neither available in the local market nor used in the smallholder dairy industry. The specific objectives of the project were to (i) assess the suitability of the proposed solar powered dairy production technologies for smallholder dairy production systems in Malawi, (ii) assess the quantity and quality of milk produced after the introduction of the technologies, (iii) assess the socio-economic and gender impacts of the technologies, and (iv) promote the uptake of the technologies among smallholder dairy farmers in Malawi.

With support from a public – private partnership (PPP) arrangement supported by the Science Granting Councils Initiative and the Malawi National Commission for Science and Technology (NCST), the project was implemented in collaboration with Orifice Irrigation and Water Supply Limited.

The research project concludes that these two solar powered technologies can revolutionize and modernize the small holder dairy industry and recommend dairy farmers should be encouraged to adopt the solar powered technologies through proper business models and government intervention to provide a conducive environment for private sector financing.

Introduction

The use of renewable energy technologies has the potential to increase the productivity of industries and businesses which in turn can attract further investment and economic growth. The current energy situation in Malawi calls for adoption and use of renewable energy to spur national development.

Malawi is an agro-based economy where agriculture accounts for 36% of the country's Gross Domestic Product (GDP), 90% of Malawi's export earnings and employs 70% of the active labour force. Despite this, only 25% of the generated electricity is used in the agricultural sector. The dairy industry in Malawi is dominated by smallholder farmers who have no access to electricity to modernise their dairy farm activities (e.g. milking) and do not have a steady and reliable supply of clean water for watering animals and to maintain adequate levels of sanitation of cows, kraals and milking equipment. Fetching water for watering animals and cleaning kraals is the most time and energy demanding activity on smallholder dairy farms in Malawi and this activity is done almost exclusively by women.

Application of solar energy had not been extended to the smallholder dairy industry prior to the current applied research despite solar energy having been successfully introduced and adopted in other economic sectors.

Approaches and Results

A baseline study was conducted at the onset of the project to capture data on dairy production of farmers from Chitsanzo Milk Bulking Group (MBG), in Dedza Malawi. This was followed by designing the solar system to power the milking machine, water supply system and provide household lighting (Figure 1). The design of the solar energy powered systems was done in two stages: (a) development of design specifications of milking machines and (b) development of design specifications of the water pumping system.

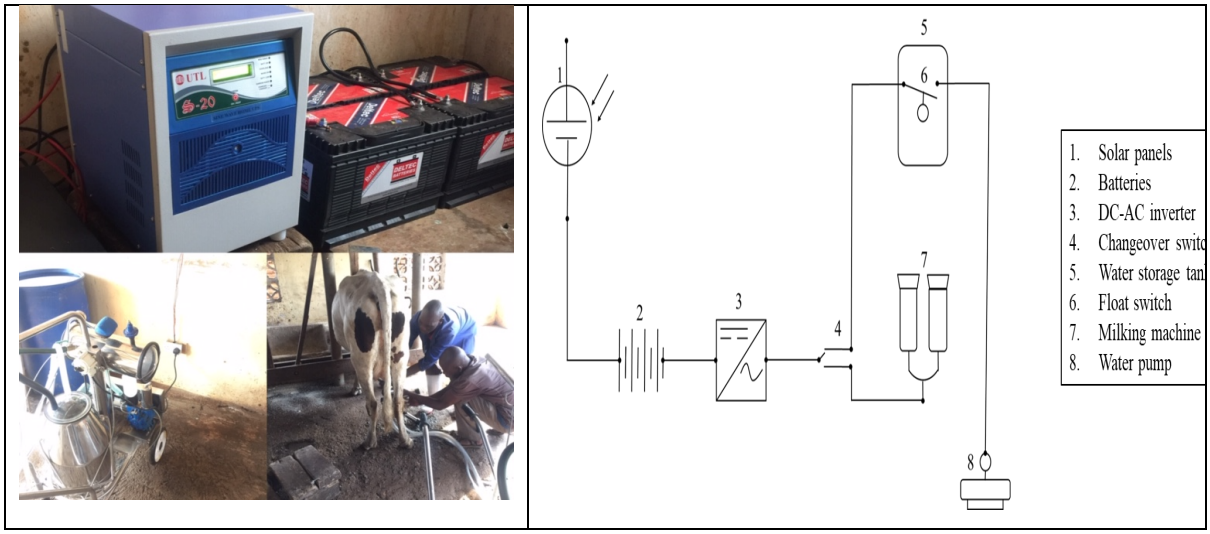

Figure 1. The design for the solar technologies and solar equipment

The designed systems were installed at a dairy farm (Farm B) owned by a farming family belonging to Chitsanzo Milk Bulking Group in Dedza and another at Bunda College Animal Students' Farm (Farm A). A third farm (Farm C) without a solar powered milking machine was used as a control. The solar powered milking machine and the beneficiary family in Dedza are shown in Figure 2.

Figure 2. Solar Powered Milking Machine

Performance of the solar powered milking machines

Field data collection on machine performance followed the design and installation of the water supply system and the solar powered milking machine. Statistical analysis of data from the study showed that there were no significant differences between average milk yields per cow from machine milking and those from hand milking at Farm A (Figure 3) despite that average milk yields for four out of the seven cows involved had slightly increased when machine milked while only three cows had slight declines.

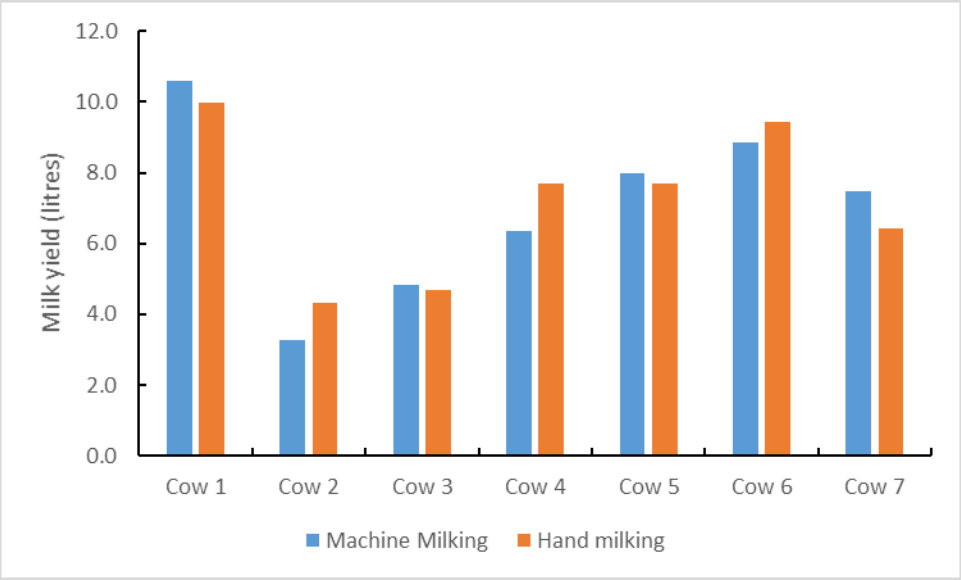

Figure 3. Comparison of milk yields under two milking techniques

The increase in average milk yields for the four cows in Figure 4 agrees with results from Farm B where an approximately 20% increase in milk yield was reported by farmer. At this farm, the cow that was being machine milked was providing an average milk yield of 10 litres when hand milked and 12 litres when machine milked.

On hand milking time, the farms with Solar Milking Machines (SMM) had the lowest milking time per cow while the one using manual milking (MM) only, had the highest (Figure 4). The differences in milking times may be attributed to differences in expertise levels among milking personnel and differences in behavior of cows. Some cows were aggressive and therefore difficult to milk.

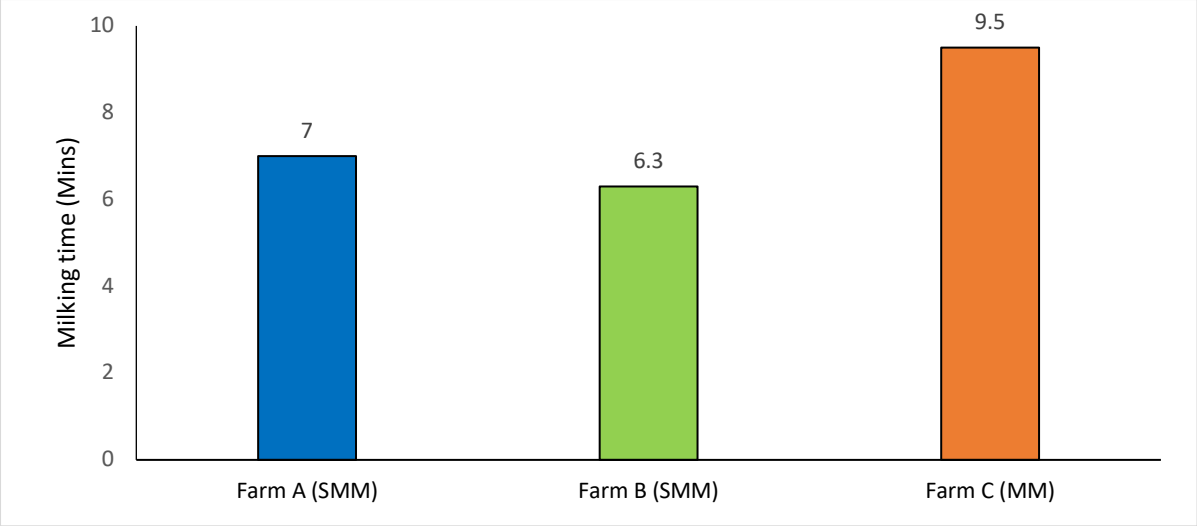

Figure 4. Average hand milking times per cow on three farms

Machine milking at Farm A was relatively faster than hand milking as can be observed from Figure 5. The Figure shows that machine milking resulted in time savings ranging from 32 to 58% across the seven cows used in the study at this farm.

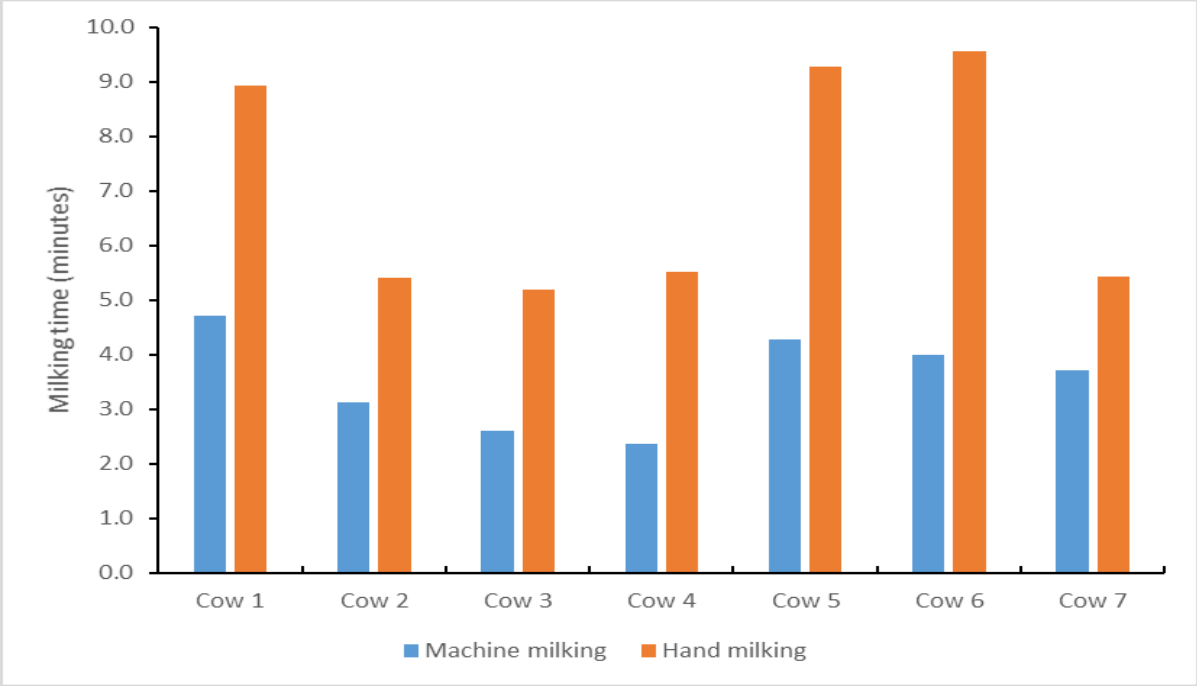

Figure 5. Milking times per cow at farm A

A similar phenomenon was observed from Farm B where the time savings due to machine milking were 51%. The results from the two farms imply that machine milking is a time-saving technique as compared to hand milking. The quality of milk obtained using the milking

machines was good as evidenced from no milk rejections experienced during the study period. Visual assessment of the milk by the bulking group farmers and the project team also indicated that the quality was good.

Benefits of the solar powered water pump

The study showed that introduction of a solar powered water pump at Farm B greatly reduced the amount of time spent fetching water for the dairy farm due to reduction in distance to the water source and reduction in time spent at the water source since the farm was initially using a communally owned borehole (hand pump). The distance to the water source got reduced from approximately 100 metres to less than 10 metres from the watering point for the dairy cattle. Most farmers (81% of the respondents) at the milk bulking group were using boreholes (apart from shallow wells and streams or rivers) as a source of water for their dairy farms and 84% of the borehole users reported that their respective farms were less than or equal to 0.5 km from the water source while 16% reported an average distance of 1 km (Figure 6).

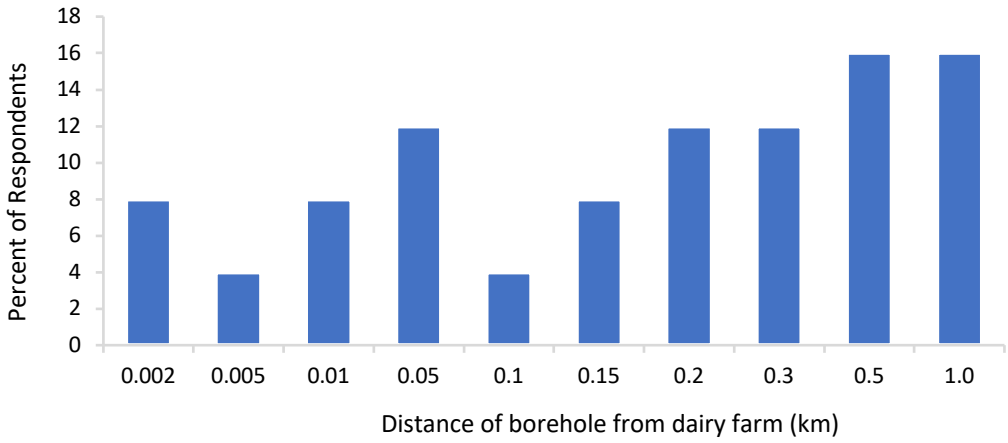

Figure 6. Estimated distances from the dairy farms to boreholes

Apart from the variations in the distances to the boreholes from respective dairy farms, the farmers stated that the boreholes used were communally owned hence there were times when the water source was congested with water users hence each user would take long time to fetch water. The average distance of the wells to the dairy farms was reported as 100 m while distances to streams or rivers ranged between 80 and 2000 m. This implies that introduction of the water pumps on the respective farms could greatly reduce the time spent on fetching water thereby releasing the time for other equally important economic activities.

Also, most of the water fetching was reported to be done by women. The women tend to have other dairy farm and domestic chores which also require a good proportion of the day hence

introduction of water pumps could minimize the time spent by women (and everyone) on fetching water.

Implications of the savings on gender

The study showed that women more dairy farming activities (52%) in Dedza were done by women compared to men (48%). It was further found that on Farm A fetching of water was done by females whilst the fetching of feed and other activities was done by males. On Farm B, just like other dairy farms owned by the milk bulking group members, water fetching was mainly done by women who were also responsible for other farming activities and domestic chores. Thus, introduction of water pumping systems on dairy farms could significantly reduce the time spent by women on water fetching thereby creating some room for them to do the other activities.

The dairy farmers under the milk bulking group reported that 83% of milking operations were done by men while the remaining 17% was by women. The low percentage of women participation in hand milking could be a clear indication that hand milking is gender insensitive to them. The farmers interviewed in the study reported that hand milking was labour intensive and time consuming thereby affecting other farming and household operations. Introduction of milking machines likely going to increase the number of women carrying out milking operation as observed at Farm B where the woman was not hand milking but is now operating the milking machine. This implies that there would be no disruptions in milking in the event that the man is not around or is not feeling well. Furthermore, introduction of the milking machine would reduce the amount of time spent on dairy farming activities by those women who are currently involved in hand milking. This would release the time saved to other equally important activities that the women do.

Socio-economic impact of solar powered milking machines and water pumps

The time saving benefit that could be realized from introduction of solar powered milking machines and water pumps could improve the economic status of the dairy farmers and nationally because the saved time could be utilized in other farming activities and other economic activities that members of the farming household could embark on. Introduction of solar powered milking machines and water pumps will also ensure that milk production is not halted due to unavailability of the men who do hand milking because women will be able to

milk the cows using the milking machines. This will ensure a steady economic standing by the farming family. Improvement in economic status of the farming families would have a positive bearing in the fight against deforestation and other similar activities which degrade the environment.

Another benefit that the solar powered technology is that the farmers would be able to use the electricity for other purposes such as provision of power for televisions, phone charging, lighting and other uses as evidenced from the beneficiary family of this project. Utilization of solar energy will also help minimize the accumulation of greenhouse gases which results from use of firewood, charcoal, diesel and petrol in provision of heat and electricity. This would have a positive bearing on the economy because the country would spend less on mitigation measures of environmental degradation and the impact of air pollution resulting from burning of firewood, charcoal and fossil fuels.

Implications and Recommendations

The research project was aimed at increasing agricultural productivity on dairy farms and also addressed the need to minimize environmental degradation which results from use of paraffin lamps, firewood, and diesel or petrol generators in providing heat energy and lighting to both the farmer and livestock on a dairy farm.

The solar Photovoltaic and the water system are presented in Figure 7.

Figure 7. Solar PV and the water storage tank

Introduction of solar powered systems on dairy farms would help reduce the amount of time that farmers spend on milking and fetching water, thereby creating some time for other economic activities.

Introduction of solar powered systems to daily farms has secondary benefits like use of the solar electricity for lighting instead of using paraffin lamps, provision of electric power for televisions, charging phones and other uses that the system could allow. For example, the current project has provided electricity for lighting, television power and phone charging at the beneficiary farms.

It is also worth noting that use of solar powered milking machines will help improve the economic status of the farming family through reduction in milk rejection rates at the selling centres because the milk so produced would be of good quality. The use of the machines prevents milk contamination from dust, animal fur and operator sweat. This is because the milk is not exposed to the open environment since it comes direct from the animal teat to the milk container through the milk pipeline. This is in contrast to hand-milking under which the milk if directly exposed to the open atmosphere and milk quality may be greatly affected by dust on windy days, animal fur and operator sweat. The milk bulking group members and the project team visually assessed the milk and stated that it was of better quality than that from hand-milking which usually had impurities. Furthermore, there were no milk rejections at the bulking group signifying that the milk was of good quality since the bulking group tests the chemical and physical properties of the milk.

The use of solar powered groundwater pumps on a dairy farm also helps ensure that the dairy farm is provided with a steady and easily accessible water supply. Milk production requires abundant supply of clean water both for hygiene and watering the dairy cows so that they give us enough milk. Dairy farmers are struggling to fetch water from long distances and most of the time, the water is of poor quality because it is fetched from unprotected open wells, ponds and streams or rivers. These water bodies are exposed to the open environment and are easily contaminated by people, livestock, surface runoff and dust.

Introduction of solar powered systems at the dairy farm is also helpful in that it helps minimize the problem of lack of or unreliable supply of electricity from the national electricity grid. The demand for electricity for both lighting and other uses on dairy farms in Malawi may not be satisfied by the national electricity grid hence introduction of solar electricity on the dairy farms will help reduce the demand for electricity from the national grid.

Furthermore, our national grid electricity faces a lot of blackouts due to problems such as inadequate water in Shire River and trash accumulation and siltation at the power plant. On the contrary, solar powered electricity is not subjected to these challenges hence its availability is guaranteed for the whole year. Introduction of solar powered systems to dairy farms is also a way of contributing towards achievement of the Malawi Growth and Development Strategy III of increasing access to electricity both in urban and rural areas. The MGDS III recognizes energy as the lifeblood of the economy as it serves as a crucial input into all critical social and economic services. Hence, introduction of solar powered technology into the dairy industry is a step in the right direction towards achievement of this very important government development strategy.

Recommendations

The current prices of solar powered equipment and other accessories could hinder adoption of this innovation on the dairy farms. In view of this, deliberate effort needs to be taken towards ensuring that introduction of solar powered technologies in the dairy industry is enhanced. Such efforts could include:

Fiscal and tax incentives

- Farmers should organize and mobilize themselves to lobby for provision of subsidies or reduction/ removal of taxes on equipment needed for installation of solar powered systems on dairy farms. This would increase adoption of the innovation because it could make the equipment more affordable to the smallholder dairy farmers.
- The Malawi Government needs to encourage adoption of solar powered technologies on dairy farms by putting in place administrative and monetary policies (e.g. subsidies on solar powered equipment and accessories installed on dairy farms) that would create an enabling environment for adoption of such technologies

Initiate revolving fund and loan schemes

- Introduction of revolving fund loan schemes to milk bulking groups whose farmers have shown interest in owning such systems. The revolving fund loan schemes could be financed through the milk bulking groups who already have experience in managing loans for their members.
- In order for the proposed revolving fund loans to be attractive and be able to achieve the intended purpose, the financing agency may need to charge affordable interest rates to avoid limiting access to the loans.

- The creation of revolving fund loan schemes could be facilitated by government and/or non-governmental organizations and may need to be done after thoroughly assessing and/or building the capacity of the milk bulking group in managing revolving funds.

Role of government and other actors

- Both government and non-governmental organizations need to take an active role towards enhancement of adoption of the solar powered technology in the dairy industry in order to contribute towards achievement of the MDGS III in the energy sector