Briefing Note

Key Lessons from an Assessment of a Community-Based Solar Water Pumping System in Bati, Southeastern Cambodia

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IP 7: Farmer-Led Irrigation for Climate-Resilient Agri-Food Systems

Synopsis

Over the past two years, the Royal University of Agriculture (RUA) and the International Rice Research Institute (IRRI), with financial support from the ASEAN-CGIAR Innovate for Food and Nutrition Security Regional Program, conducted multiple visits to a community-based solar water pumping (SWP) site in Bati District, Takeo Province, which is part of the rainfed lowlands of southeastern Cambodia. The SWP system, funded by the AIMS project under the Ministry of Commerce, has been in continuous operation for three years, primarily to irrigate vegetable crops such as cucumber, eggplant, and winter melon. RUA and IRRI were already familiar with the site from previous visits associated with other research activities. This Briefing Note presents key findings from interviews and focus group discussions with households involved in the SWP system, highlighting the system's operational functionality and the benefits it provides. It emphasizes the importance of the SWP setup for the community, the active engagement of members, and cooperative management to ensure equitable water distribution. However, an overestimation of the SWP's water supply capacity at the onset has led to shortages for some members who rely on the system for crop irrigation. Despite this, using solar irrigation potentially reduces costs associated with using diesel pumps. To support the successful expansion of community-based SWP systems in Cambodia, careful system capacity estimation, strong technical support, a well-defined fee collection mechanism for operation and maintenance (O&M), and access to spare parts are essential and should be prioritized.

This work is part of Intervention Package No. 7: *Farmer-Led Irrigation for Climate-Resilient Agri-Food Systems* under the ASEAN-CGIAR Innovate for Food and Nutrition Security Regional Program.

Context and System Design

- In 2020, the Ministry of Commerce, in partnership with the International Fund for Agricultural Development (IFAD), implemented a project titled "Accelerating Inclusive Markets for Smallholders (AIMS)" to promote safe local food production in 11 provinces. Among them, Takeo province was also included, with a needs assessment performed in a location where an introduced community-based solar water pumping (SWP) system could contribute to improving vegetable production. After the needs assessment, an informal vegetable group situated in Trapeang Ang Village, Kraing Leav Commune, was selected, largely due to its active vegetable production that was severely impacted by restricted access to an 80-ha natural lake placed under long-term renovation by the Ministry of Water Resources and Meteorology (MOWRAM). With the long-term lake restoration project, vegetable production almost collapsed in the commune due to the absence of irrigation water. As a result, the number of vegetable farmers in the commune dropped from about 100 to a few dozen. Some of those who remained began to make use of the SWP system.

- Before the SWP system setup, the AIMs project conducted several group discussions with local authorities and vegetable farmers to select a suitable site in the village for the construction of the SWP system. Initially, dozens of farming households (HHs) participated in the discussions, but at the end of the initial consultation process, only 10 HHs were selected as beneficiaries of the community-based SWP system. The selection was based on a few key criteria: active in vegetable farming; situated close to the plot fields; and commitment to donate land for the construction of the SWP system. The selected households were an informally established vegetable farming group that is either relatives or close neighbors. They all grow vegetables such as cucumber, winter melon and eggplant, primarily to supply the market.

- The solar water pumping system was designed by a technical group from the AIMS project and installed on the land owned by one of the group members. Other group members helped clear the land, and one of them donated the land for the installation. The installation cost was borne by the project (12,000 USD), and after completion, the group was trained on basic operations. A group member who had considerable farming experience and a larger plot size was also chosen as the head of water user group (WUG). After the WUG establishment, fees of the SWP system were charged at a fixed rate of 20,000 riels/month (5 USD/month), but the collection was done during only the first six months because there was no formal written consent in place. The farmer group was told to report any irregularities in the system to the project without attempting to fix the issues themselves. The WUG was not allowed to make any changes to the system; any modifications without prior notification to the AIMS-appointed engineer are considered non-compliant with the regulations.

- There are 10 HHs in the SWP system, and three of them are female members. On average, the 10 HHs have a household size of 4-6, while the age of the family head varies from 40 to 60. All of them grow both rice and vegetables: rice is chiefly planted for home consumption and vegetables for sale. Rice and vegetables are planted on separate plots, while rice is rainfed and vegetables are grown using water supplied both by the SWP system and by rainfall. Vegetable plot sizes vary from 0.1-0.7 ha per household, while the average is around 0.3 ha. Specifically, 5 HHs have 0.1-0.2 ha; 3 HHs have 0.2-0.4 ha; and 2 HHs have 0.6-0.7 ha (Table 1).

Table 1. Plot size per household and current farming status

Household (HH)	**Vegetable plot size**	**Current farming status**
1	0.70	Continue
2	0.60	Continue
3	0.40	Continue
4	0.30	Continue
5	0.22	Continue
6	0.20	Continue
7	0.17	Stop
8	0.15	Stop
9	0.10	Stop
10	0.10	Stop
Mean	**0.30**	

Table 2. Overview of the SWP system

Components	**Details**
Technical	• 1 tube well (around 47 metres deep) • 2 solar panels (2 kW total capacity) • 1 submersible pump (1.5 kW capacity) • 2 overhead tanks (2 kL total capacity, elevated 5 m above ground) • Water piped to and stored in three ponds shared by the 10 households. The ponds were excavated by the WUG later after the completion of the SWP system to store groundwater. Two of the ponds are approximately 20 m long x 10 m wide x 4 m deep, whilst the third is approximately double this size.
End-use	• Domestic supplies for 10 households (5-10% of the water is used for washing/bathing). Meanwhile, rainwater is stored in large jars for cooking and drinking. • Vegetable production group (90-95% used for irrigation)

Figure 1. Layout of the SWP system (garden and water pipe locations are indicative)

Figure 2. A 1.5-kW community-based SWP system installed by the AIMS project for a vegetable community in Trapeang Ang Village, Kraing Leav Commune, Bati District, Takeo Province (left) and eggplant grown near the SWP system.

Figure 3. Two of three open ponds, averaging 20 m in length, 10 m in width, and 4 m in depth, excavated by the vegetable community to store rainwater and groundwater supplied by a solar-powered water pumping system.

Figure 4. Cucumber cultivation on land of a SWP group member in the community (left) and clearing of an eggplant plot for next crop cycle by another member (right)

Figure 5. Land preparation by a SWP group member for new crop cultivation (left) and plastic mulching setup in preparation for transplanting cucumbers by another member (right)

System Operation

- The SWP system runs automatically and whenever the sun rises in the morning, water starts to be pumped to the elevated tanks and is then distributed to the storage ponds. There are three ponds used for storing groundwater before being irrigated into the vegetable plots. Each pond is replenished with water over a one-week period on a rotational basis for the several group members that share each pond. This is done to ensure equal water distribution in the WUG. According to the initial calculations performed by an engineer from the AIMS project prior to implementation, the SWP system was thought to supply enough water for 3.5 ha of land, which was adequate for all HHs. However, actual implementation showed that the water was enough to irrigate only 0.5 ha, making it hard for all HHs to irrigate crops at the same time. As a result, the WUG decided to take turns in pumping water to ensure equal distribution.
- At the beginning of SWP operation, the WUG collected fees for O&M, but after six months, fee collection was stopped because of the absence of regulatory controls. This is because the system has no problems with pumping, but in the long run, this can pose a serious issue in the future when budget is needed for any repair. Each of the three ponds receives water throughout the week on a rotational basis. This is based on a verbal agreement among the WUG. However, it can be adjusted accordingly in case of urgent demands. All HHs respect and follow the regulations strictly and no complaints arise among the group. After the installation of the SWP, vegetable production increased to 2-3 cycles annually as compared to only 1-2 cycle before the SWP.
- Groundwater pumped by the SWP is not transported directly to crops, instead it is stored in ponds overnight first before being used for crops. Then, all households use electrical motors to pump water from the ponds to their crop fields. The use of groundwater from the SWP for crops varies by season. In the dry season, the SWP works all day from early in the morning to late in the afternoon, which is about 8-10 hours, to pump water into the ponds. Because the capacity is enough for one or two small plot sizes, HHs that have large farm sizes resort to submerging an electrical pump into the tube well to pump water at night, which takes about 5-6 hours. However, in the rainy season, rain water is also available, so the operational time of the SWP system for vegetables is reduced to 4-5 hours per day.
- Due to fluctuating vegetable prices, 4 out of 10 HHs were forced to leave farming for work at a nearby factory. The reason is that those HHs have small plot sizes (about 0.1-0.2 ha), so growing vegetables was not profitable. Additionally, their fields were somewhat far from the storage ponds, making them reluctant to continue farming. As a result, they decided to work in the garment industry to have a secure source of income. They plan to return to farming if vegetable prices are high enough, and water supplies are sufficient. However, the

remaining group members are satisfied with their current farming because they have large enough fields and use other power sources to ensure enough irrigation, primarily during the rainy season. They can increase their productivity and are willing to pay up to 25% of the cost of a future SWP system if there is a similar project in the community.

*"I am so grateful to have a solar water pumping (SWP) system for my crops. It reduces my dependency on diesel while allowing me to maintain vegetable productivity and consistent planting cycles. Previously, I struggled to find water for my crops during the dry season, but now I feel relieved," said **Mr. Kan Kimlong**, a 32-year-old WUG member in Kraing Leav District. "I plan to expand my production, so I'm eager to install another solar pumping system if a future project arises. I'm even willing to contribute up to 25% of the cost."*

Major Learnings

(1) Proper calculation is required to match the SWP system supply and plot size

The water balance of the SWP system was miscalculated, underestimating the amount of water necessary for the total area intended for irrigation (3.5 ha). However, the actual water available for irrigation was only 14% of the total demand (when the land of all WUG members was considered), making it hard for all the group members to be provided with adequate water for their crops. The shortage of water supplied by the SWP system led to the use of electrical motors to pump groundwater from the tube well at night to ensure sufficient irrigation. Small plot sizes and insufficient water supplies were the factors that influenced some of the farmers' decision to leave farming.

(2) Initial support leads to farmers' interest in the SWP system

Before having the SWP system in the community, the farmer group depended both on water drawn through canals from a large lake in the village and on rainwater to irrigate vegetables. Vegetable farming used to be active, but the lake was placed under long-term renovation, so more and more farmers reduced the farming and the plot size. When water was available from the lake, farmers commonly used diesel pumps that were not only costly, but also contributed to greenhouse gas emissions. The difference in farming became clear between farmers with and without a solar pumping system. The group that gained access to the solar pumping system could maintain their production and cycle number, while others stopped farming due to their struggle to find water for irrigation. Additionally, both time and money could be saved, largely due to the availability of sunlight for pumping. Since then, more and more farmers are interested in adopting a similar SWP system and willing to pay some of the construction cost. It is clear that through the initial support, farmers have gained experience with solar pumping, attracting others to do the same.

(3) Fee collection mechanism should be strengthened and strictly implemented

The selected group can benefit from free groundwater pumped by the SWP system, when compared with others in the village. The benefits may be sustained over a long period if there is a budget for operation and maintenance (O&M). The donation was given one time only at the beginning, while the operational cost is the sole responsibility of the group. Therefore, collecting fees from the members can show commitment and ownership of the system, while the budget can be used later for any breakdowns that may arise. Such a fee collection mechanism should be supported by local authorities or a form of mutual consent in the group. In the absence of external support, the group leader should be determined enough to undertake this task.

(4) Technical knowledge of the SWP system is required to ensure smooth operation

Basic training was provided to the farmer group, but its primary purpose was to ensure they knew the system. However, through the interviews and group discussion, the farm group mentioned the training was short and was conducted only one time. Therefore, understanding the functionality of the system is not guaranteed. Additionally, they did not even know how to read the solar power counter, or how to clean the solar panels, so in the long run, the system may not function properly. Thus, more training should be provided, illustrating the system function in a simple way or by using notices in Khmer. This enables the farmer groups to follow strict O&M procedures.

(5) Linking solar pump suppliers to vegetable groups is key to increasing solar pump adoption

Demands for solar pumps have started to increase to some extent, but the real installation may not happen when there are no known solar pump suppliers in the community. It is reported that it is hard to find locations that supply solar pumps or provide related services. As a result, this may lead to reluctance to use solar pumps due to the concerns over O&M. To address this issue, support from local authorities or relevant stakeholders familiar with the supply should step in and link suppliers and farmers.

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