RESEARCH NOTE

NATURAL RESOURCE MANAGEMENT WITH SPECIAL REFERENCE TO SOLAR WATER PUMPING SYSTEM IN SIRAHA DISTRICT

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Introduction

This article is based upon a research study conducted for Alternate Energy Promotion Center of HMG in 2000. It assesses and analyzes the status of Solar Water Pumping System SWPS installed for drinking, domestic and irrigation purposes in Todke, Bhulke and Phulbariya villages of Siraha district. The findings of the study, therefore, will be useful for the planners, administrators, concerned organized village people, researchers and students. The overall objective of the article is to explain the present status of solar PV water pumping system in Siraha district to assess performance and problems of SWPS, to assess impacts of SWPS in Siraha district; and to provide suggestions on how solar SWPS can be made more popular as well as affordable for village people.

Approach and Methodology

The methodology adopted in the study is qualitative and quantitative. The study is mainly field based and descriptive. It uses both primary and secondary sources of information. The secondary data were collected from WECS, NSES, AEPC, National Planning Commission Secretariat, Center for Renewable Energy, Center for Energy Studies of Institute of Engineering, REDP of UNDP, Royal Nepal Academy of Science and Technology and other related organizations. The primary data is collected through field visits. Three sets of semi-structured questionnaires were developed and served to the members of the user groups of SWPS and manufactures or organizations

Contributions to Nepalese Studies, Vol. 28, No. 1 (January 2001), 109–124

installing the systems. The field survey was conducted during May 2000. Taking interview with the members of user groups of SWPS who were using water for drinking purposes and irrigation purposes, semi-structured questionnaires were filled up. The qualitative data was collected through focus group discussion with the user group members and key informants of the village. Three sites of the Siraha as Todke, Bhulke and Phulbariya were included in the study.

Status of Solar Water Pumping System in Siraha District

The status of solar water pumping system in three sites of Siraha district is described in Table 1.

Table 1: Purpose of SWPS in Todke, Bhulke and Phulbariya

District	Site	Domestic consumption	Irrigation purposes	Both	Remarks
Siraha	Todke	1			Community user
	Bhulke	1			Community user
	Phulbaria		1		NGO/Community user

Source: Field Survey

The detailed investigation and analysis of SWPS of the above-mentioned sites is described below.

SWPS in Todke

The site is located at Lalpur VDC, Ward no. 3 of Siraha district. The year of installation was November 1999. The source of water for pumping is deep well. It was drilled on March 1980 and the static water level is 75' and the bore size is 10" x 6". Maximum discharge at maximum head from this SWPS is 25 m3 per day. The Pump set manufacture is Grundfos and Pump set model number is 3A-10. Regarding the performance of SWPS in Todke it is successfully running since installation.

It was found from the field visit that 150 families benefited from SWPS.

The submersible pump was installed at a depth of about 30m from the ground level with 2' dia riser pipe and outlet is connected to the existing reservoir tank. From the date of installation, the system is pumping about 25-

35 m3 water per day. At present, the system is working smoothly. The community peoples with the assistance from ECCA repair and maintains the system whenever required. The Supplier Company takes the responsibility of repairing and maintaining the pump.

SWPS in Bhulke

The site is located at ward-number 5, Bhulke village in Siraha district. The year of installation was November 1996. The source of water for pumping is deep well. The static water level of the pump is 60 ft. and bore size is 10"x6" The community owned this SWPS. The capacity (Wp) is 60 kw. Maximum discharge at maximum head from this SWPS is 30m^3/day.

The Pump set manufacture is Groundfos and Pump set model number is Groundfos 5A. In Bhulke, 80 families are being benefited from SWPS at present. The performance of the pump was found satisfactory. The pump is successfully running since the date of installation. The system is designed to deliver an average of 50,000 liters water per day. But the actual performance is slightly low, which is about 40,000 liters per day. This is due to the deeper water level of the well.

SWPS in Phulbariya

The site is located at ward-number 8, Phulbariya village in Siraha district. It was installed in August 1998. Resource Multiplication and Research Service Center for Agriculture Sustainability implemented the project with the technical assistance from Nepal Solar Electricity Company. The source of water for pumping is deep well. The module capacity (Wp) is 70m. The Pump set manufacturer is Shurflo, USA. The pump type is submersible and Pump set model number is 9325-043-101/014973. As regards the performance of SWPS in Phulbariya, it is working satisfactory and running successfully since installation. The long flexible 1/2" pipe connected to the solar pump is taken to the point of MRSC project. Maximum discharge at maximum head is 136 liters per hour.

'With the help of SWPS, wheat farming was introduced in 3 ropanies even in winter season. The production was satisfactory. The users' are happy and satisfied with the system. The users repair and maintain the system whenever required. The supplier takes the responsibility of maintaining the pump.

Impact of SWPS on Health and Hygiene: A question was asked to the user members of SWPS for domestic purposes whether there was any impact

from SWPS on their health and hygiene and their family members after the installation of SWPS in their locality.

Table 2: Perception of Respondents Regarding the Impact of SWPS on Health and Hygiene.

Sites	Impact of PVWPS on Health and Hygiene		Remarks
	Yes	No	
Todke	√	–	Positive
Bhulke	√	–	Positive
Phulbariya	√	–	Positive

Source: Field Survey

Almost all of the user respondents of SWPS for household purposes agreed that after the installation of SWPS there was a change in their health and their family members due to sufficient supply of quality water.

Regarding a question whether they had to face any health problems related to water borne diseases only 20% respondent said yes as against 80% who reported that they did not face health problem related to water borne diseases during last year.

Of the respondents who reported of health problem during last year 20% reported the problem as diarrhea and typhoid.

Similarly almost all the respondents reported that after the installation of SWPS they found some changes in sanitation around their houses. They found the clean environment after they received water from SWPS.

Impact of SWPS on Men, Women and Children: The impact of SWPS as experienced by respondent users of SWPS for domestic purposes is presented in Table 3,4, and 5 respectively.

The result from the analysis of data indicates that 60% respondents found an increase in their daily work schedules and leisure time activities and time to teach children and saving as against 40% who reported the decrease in those activities and did not find any changes. Similarly, 40% reported an increase in income generating activities, while about 60% did not find any change. Almost 100% of the respondents reported positive change in health and hygiene. The respondents, who were using SWPS only for drinking water

purposes, did not find any change in agricultural production as vegetable production and livestock raising from SWPS. About 80% reported the decrease of expenditure after the installation of SWPS while 20% did not find any change.

Table 3: Impact of SWPS on Men

S.N.		Increased %	Decreased %	Same %	Total % (N=5)
1	Daily work schedule	60	20	20	100
2	Sleeping hours	40	-	60	100
3	Leisure time activities	60	20	20	100
4	Income generating activities (specify in monthly income)	40	–	60	100
5	Time to teach children	60	-	40	100
6	Health and hygiene	100	-	-	100
7	Income	20	-	80	100
8	Agriculture: a. Livestock raising b. Vegetable production	 – –	 100 100	 100 100	
9	Saving	60	-	40	100
10	Expenditure	-	80	20	100

Source: Field Survey

About 40% respondents reported the increase of women's daily work schedule, sleeping hours, leisure time activities and agricultural production, whereas about 40% reported the decrease in women's daily work schedule and 20% did not find any change. Similarly, 20% found the decrease in leisure time activities of women, and 40% did not find any change. Regarding income generating activities the entire respondent did not find any change in women's activities. Likewise 40% viewed that there is no change in time to teach children by women. As regards agricultural production, 60% did not find any change. About 60% reported the increase in saving, while 40% reported the same. Likewise, 20% found the increase in expenditure while 40% found the decrease and 40% found no change.

Table 4: Impact of SWPS on Women

S. N.		Increased %	Decreased %	Same %	Total % (N=5)
1	Daily work schedule	40	40	20	100
2	Sleeping hours	40	-	60	100
3	Leisure time activities	40	20	40	100
4	Income generating activities (specify in monthly income)	–	–	100	100
5	Time to teach children	60	–	40	100
6	Health and hygiene	100	–		100
7	Income	20	–	80	100
8	Agriculture:				
	a. Livestock raising	40	–	60	100
	b. Vegetable production	40	–	60	100
9	Saving	60	-	40	100
10	Expenditure	20	40	40	100

Source: Field Survey

About 40% respondents reported that daily work schedule of the children increased after the installation of SWPS, while 60% viewed it as the same. As regards the sleeping hours and leisure time activities, 20% reported the increase, while 80% did not feel any change. Regarding the change in income generating activities of the children, 80% did not answer and 40% mentioned no change.

Table 5: Impact of SWPS on Children

S.N.		Increased %	Decreased %	Same %	Total % N=5
1	Daily work schedule	40	–	60	100
2	Sleeping hours	20	–	80	100
3	Leisure time activities	20	–	80	
4	Income generating activities (specify in monthly income)	–	-	40	100
5	Health and hygiene	80	–	20	100

Source: Field Survey

Impact of SWPS on Agricultural Production

The SWPS is being used for irrigation purposes only in Phulbaria. The main purpose of SWPS for irrigation is to increase the agricultural production of the land. The benefit from the production should exceed the cost of SWPS while analyzing the cost/benefit ratio of SWPS. The source of water for cultivation before the installation of SWPS in Phulbariya was only rainwater and manual parting from the river and well.

Table 6: Average Size of Land Holding of User Respondents

Site	Average size of land holding	Categories of land	Remarks
Phulbariya	17 katha	Community owned	Managed by NGO

Source: Field Survey

Cost and Income Comparison before and after the installation of SWPS is presented in Table7 and 8. The cost comparison is based upon the views of user respondents of SWPS for irrigation purposes of Phulbariya. It was found that the costs have been increased after the installation of SWPS.

Table 7: Cost Comparison before and after the Installation of SWPS

Site	Cost per year					Total
	Seed	Labor	Fertilizer	Pesticide	Marketing	others
Phulbariya: (MRSC managed land)						
Before	2000/-	14400/-	14400/-	–	NA	30800/-
After	3800/-	36000/-	36000/-	–	NA	75800/-

Source: Field Survey

Table 8: Income Comparison before and after the Installation of SWPS

Site	Income earned per year		Remarks
	Before installation of SWPS (yearly)	After installation of SWPS (yearly)	
Phulbariya (MRSC managed)	7,800/-	1,32,000/-	community owned and managed by NGO

Source: Field Survey

Table 9: Views of Respondents Regarding the Changes Experienced in Income, Expenditure and Saving after the Installation of SWPS in Phulbariya

Site	Changes in income expenditure and saving			Remarks
	Increased	Decreased	Same	
Phulbariya Income Expenditure Saving	–	–	–	Positive impact

Source: Field Survey

It was found that respondents of the Phulbariya reported to have increased in income, expenditure and saving.

The 17 katha land is under the ownership of community people and is being managed by MRSC a local NGO. Before the installation of SWPS the NGO earned Rs. 7800/- only. After the installation of SWPS due to the irrigation facility the organization started farming additional vegetables and fruits like mango, litchi, guava, banana, papaya, pineapple and so on.

Time Allocation of Men/Women in Water Collection before the Installation of SWPS

It was described earlier that before the installation of SWPS the source of water for domestic purpose is river, pond and well. The men and women had to spend much more time to collect/ fetch water before the installation of SWPS since they had to go far from the house.

A question was asked to the users of SWPS how much time they have to spend to collect/fetch the water before the installation of SWPS in their area. The information received from the user respondents is presented in Table 10.

Table 10: Time Spent by Men/Women to Collect the Water before the Installation of SWPS

Time	Percentage	Average time spent to collect water
Less than half hour	–	
Half hour	50%	one hour
One hour	25%	
More than one hour (1.5 hour)	25%	
Total	100%	

Source: Field Survey

Note: Applied only for Todke and Bhulke

For the 50% respondents, it took half an hour to collect the water before the installation of SWPS while for other respondents it took about one hour or more than one hour (25% each). The average time spent by men/women to collect the water before the installation of SWPS is found to be one hour per day. After the installation of SWPS the less time is spent to collect the water for their household consumption.

In the case of irrigating the land before the users have to depend only on rain or have to irrigate by manual water parting which have to collect from river, pond and well. It took more time so that they grow only maize or cultivate vegetables only on the limited land for their daily consumption purposes.

Linkages between SWPS and Environment

SWPS is environmental friendly technology. It produces no noise while in operation and produces no pollution in air and land. Besides, SWPS helps in better conservation and management of water and agricultural land. There is no environmental effect from SWPS. Instead, SWPS provides safe water. It helps in promoting good health to the community people and in irrigating land

in Phulbariya. In all three sites of Siraha district, there is no adverse environmental effect from SWPS.

Users' Experience with Performance of SWPS

All the pumps installed for drinking purposes and irrigation purpose in three sites are working smoothly.

The opinion of respondent users regarding the performance of SWPS in Todke, Bhulke and Phulbariya is presented in Table 11.

Table 11: Opinion of Users Regarding the Performance of SWPS

Site	Satisfied/ Unsatisfied	Remarks
Todke	satisfied but not fully	the users wanted to have more supply of water (working smoothly)
Bhulke	satisfied	working smoothly
Phulbariya	satisfied	working smoothly

Source: Field Survey

The respondent users of Bhulke and Phulbariya sites are found satisfied. The user respondents of Todke reported that they are satisfied but not fully, since the water discharge from the pump is insufficient all the time as per their need for all the user families.

However, the SWPS can provide drinking water without requiring any fuel or extensive maintenance. SWPS may allow people to do more productive activities and can thus improve the quality of life. The drudgery of women and children who otherwise keep themselves engaged in bringing water from far off distances can be reduced significantly. SWPS has no moving parts and hence is highly reliable and durable and is modular in nature for future expansion.

Cost-effectiveness of PV pumping system depends upon various factors such as climate, water resources, and demand for water, technically good institutional and economic characteristics. The summary of factors favouring PV water pumps in Siraha district is presented below:

Table 12: Factors Favoring SWPS in Three Sites of Siraha District

Factors	Favorable conditions
Climate/water resource	• Solar irradiation high in sunny days • Static lift not great • Seasonal variation in water depth small
Demand	• Water demand neither high nor peaky, irrigated land area small • Conveyance losses low • Field application efficiency good • Farmers/people prefer the system
Technical	• Array efficiency good • Sub system efficiencies good • Lives of principal components long • Wind regime poor • Low sustained human power inputs
Economic	• Capital costs subsidized/ Assisted • Water has high value • Diesel fuel is expensive and supplies are erratic

Source: Field Survey and Observation

Problems of SWPS

Though the application of solar energy has a number of attractions it faces some problem, that vary from site to site. The main common disadvantages of SWPS are high initial capital cost and low output in cloudy weather. Though solar pumping system is designed to be maintenance free for lifetime of the equipment, it needs some repair and maintenance costs in some cases. In some cases, cables (wiring) may damage due to rats and human errors. Most common problem of the Shurflo submersible pumps is non-cleaning of the filters of the pumps, which reduces the efficiency. Most of the fault for Groundfo inverters is due to human error. Other major problem in repair and maintenance is due to well conditions where deep tube well solar pumping system is used. Similarly, problems in the well are mainly lower discharges which cause draw down, sand blowing due to damage of filters etc. Since the most of the solar pump are installed in old wells replacing the diesel pump or others this is the critical in the deep tube well pumping.

The specific problems found from the field visits in each site are as follows:

Problems of SWPS in Todke

- Incapability of users to handle simple repair and maintenance works
- Lack of spare parts in the local market. The users have no spare parts of the installed system in their possession.
- Lack of trained manpower at the local level
- User groups are too large and it is very difficult to manage for the caretaker of the SWPS. The problem of distribution of water was also aggravated. The large group did not get sufficient water according to their need, since the capacity to pump the water is not sufficient for existing user families.
- Lack of responsibility among user groups
- In some instances, dry running of pumps, which affect the inverter system
- Water contains fine silt, which caused the impellers and rubber bush of the pump to corrode.

Problems of SWPS in Bhulke

- Array did not include by pass diodes and that the water level in the well was deeper than expected .The community people estimated the water level at 35-45 feet, while the actual level was measured be about 68 feet. The water may drop further during the dry season.
- Users lack the knowledge about what plumbing parts would be available in the local market.
- Lack of training on repair and maintenance for the community people so that even for a minor repair and maintenance the supplier had to send the technician from Kathmandu.
- Lack of trained manpower at the local level
- Lack of awareness among people
- Lack of responsibility among user groups
- In some instances, dry running of pumps, which affect the inverter system

Problems of SWPS in Phulbariya

- Lacks sustainability programme
- Lack of trained manpower at the local level
- The pump is being used for irrigation and it needs water in time so delay

in maintenance may create headache to them. The technicians were not locally available and they had to send the parts to manufacturer, it can take long period. The equipment needed constant repair and maintenance after 3 years of functioning.

Findings of Focus Group Discussion

To acquire relevant information, focus group discussions with users of SWPS in all the three sites were conducted. The outcome of the group discussion is presented below.

- The users received information about the SWPS from different sources, mainly from the organizer, researcher and manufacturers. SWPS are installed as an experimental project at many places. ECCA, SEC/PANAS, NSES, Lotus Energy Company, were the various institutions involved in it.
- In general, the users respond positively about the advantages of SWPS. Easy availability of water made the house hold work easier for women and children. In the group discussion the members of the user group were asked to provide information about the economic condition. The farmers sell their crops in the market and buy their daily requirements like salt, oil, cloth and other needy items, so both the income and expenditure increased equally after the installation of SWPS.
- It was also found that the local people could use the SWPS for the growing of cash crops, by getting micro-irrigation facilities, which would be highly useful to increase their income. The land was dry and useless before the installation of SWPS. After the installation of SWPS they started to produce seasonal and off-the-season vegetables and fruits. The users expected to get more return after few years.
- With regards to the maintenance of the system, the users informed that the training was given to the local people, and they can repair the minor problems like loosed wire connection. If the users can not repair the system, they inform the organizer/ installers and the technicians repair it promptly. The farmers are satisfied with the system and willing to pay small amount (Rs. 60-100) per month for the use of water because they think it will help to raise funds for repair of the system.
- The users were of the opinion that more SWPS should be installed, as the SWPS is highly useful for farming cash crops and vegetables. They

also expressed the view that since full payment for the system is beyond their capacity, the government should provide subsidy and interest free loan for a long period.

- In conclusion, the users feel that the system is useful for the improvement of their lifestyle, health, economic condition and social well being.
- The Todke system has not experienced any major problem till date. A minor technician is appointed by the users committee to take care of the system.
- The Bhulke system is also operating satisfactorily. The caretaker nominated by the user is committed and trained by the supplier of the system, is not paid for his services.
- Similarly, the system installed in Phulbariya has not experienced any major problems since the installation. Since the system is owned by a NGO, it is well care-taken.

Conclusion

Solar energy in Nepal is abundantly available and is renewable. The SWPS can be used easily for water supply for domestic purposes and irrigation purposes. Solar water pumping is best suited for villages because of the small quantities of water involved and the high value of delivering clean water for drinking. It also can be used for additional supply of water for domestic use purposes in urban areas.

In case of SWPS for irrigation, its application is suitable for micro irrigation for cash crops like vegetables farming, floriculture and fruit farming. Less than one kilowatt capacity of PV pumping systems are popular in rural areas of Nepal because of the modular few moving parts, little maintenance and high reliability. If the SWPS was properly managed, it is feasible and economically viable for rural as well as urban areas of Nepal for drinking water supply and irrigating the farm. The performance of SWPS in rural areas if found to be satisfactory and its impact is found to be positive with regard to present situation. There is a positive effect of SWPS on health and hygiene due to clean and safe water supply. Farmers can grow cash crops as vegetables and fruits and develop agricultural production with the help of irrigation facility from SWPS.

The people should be mobilized by creating awareness and providing general training on repair and maintenance of SWPS. Similarly monitoring

and evaluation of the system is needed from the concerned agency involved. Thus, if regular care in operation /maintenance has been given, the system will operate smoothly. The SWPS is viable technique for the country for supply of drinking water and irrigation of the farm field.

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