ROLE OF MICRO HYDROPOWER IN IMPROVING FAMILY INCOME AND SOCIO-ECONOMIC STATUS OF THE RURAL HOUSEHOLDS OF LUNDKHAWAR, DISTRICT MARDAN-PAKISTAN

NAJMUL SAQIB[1*], HIMAYATHULLAH KHAN[2], GHAFFAR ALI[3] and SYED MUHAMMAD AMIR[4]

1 Institute of Development Studies, the University of Agriculture Peshawar.*
2 Institute of Development Studies, the University of Agriculture Peshawar.
3 The Department of Agricultural economics The University of Agriculture, Peshawar.
4 College of Humanities & Development studies, China Agriculture University-China.

ABSTRACT

The aim of the current study is to highlight the role of a micro hydropower project in improving family income and socio-economic conditions among the rural households of Lundkhwar. The micro hydropower project were launched in 2007 on upper swat canal (Machai branch) near Kandow village, with 1-3 mega watt power generation capacity from the hydropower. The beneficiaries belong to different villages in which only three villages Kandow, Chiel and Madad khan banda were purposively selected for the study. About 31% off-farm employment opportunities were created for 59% of the available labor force in the sampled population. About 47.48% increased were calculated in income of the sample households. Majority (33.3%) had improved their house structure (constructing new rooms, kitchen, washroom, toilets), about (18%) spent on children education and (17.3%) improved their household intake with 46.71% change in expenditure of the sampled households. About 48.68% change were occurred to the income of households from kandow where majority 61.8% belong to agriculture occupation.

KeyWords: micro hydropower, off-farm employment, mega watt.
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1. INTRODUCTION

Hydro electricity uses energy in falling water to spin a turbine to produce electricity. Utilization of hydropower potential on a small scale is one possible approach to the decentralized electrification of rural areas. Compared to big dam, micro hydropower installations can be found in many parts of the world (Maier, 2007).
In parts of Northern Mountain Regions including the KPK, FATA, Northern Areas and Azad Jammu and Kashmir Micro hydropower projects are one of the options, through which the objectives of economic development and poverty-alleviation can be achieved in a practical way. Provision of energy could help in creation of appropriate industrial based at cottage-level in the areas where micro hydropower potential exists yet deprived of basic facilities. Which will create job-opportunities and do value addition to the agricultural products. Majority of our rural population is engaged in the sector of agriculture. Drying out of fruits and vegetables would be possible through development of latest techniques, and the export to cities will weaken the vicious circle of poverty. MHP projects can support many schemes, such as rice and flourmills, block and concrete industry and some of the available minerals-based industries (Gull, 2004).

Hydropower on a small scale, in the form of mini or micro-hydropower, thought to be the most low cost energy technologies that can be utilized for rural electrification and industrialization among developing and less developed countries. The micro

hydropower can be used as a source for income generating activities. For example micro hydro potential in Nepal has been used for work that are mechanical in nature such as milling and rice hauling (Paish, 2002).
The economic benefits of the micro hydro systems were revealed by its role in the development of small businesses like grocery shops, engineering workshops, and mechanical based small business. It facilitates textiles producers to produce more and export it to near cities as well as bakeries in the locality were capable to manufacture all the products, which they were, import from other towns. This process of economic progress of the area made it more attractive to local residents of different communities as well as people from other areas were willing to invest in these areas (Calderon, 2005).

The micro-hydels were constructed with an initial major principle to make available the electricity for lighting to the rural households not including its commercial demand at the beginning. Gender equality was also not considered during the planning stages. The activities of all the individuals including men, women and children were positively effected by the program. An effort has been made to focus on the routine of those women's served by the program and what improvements has been made in case of production and routine life. Like other rural communities, men were mostly involved in farming activities including plowing, cutting, harvesting and sowing etc as well as female members of the households have routine work includes childcare and home maintenance. Electricity supply from the micro hydels bring improvement to women output at cottage level, due to which there were increased in income as well as improved their life standard and facilitate the rural women to perform their tasks at home. Electrification from the micro hydropower also gives economic benefits by saving money spent on batteries and kerosene oil (Ummar and Khan, 2006).

1.1 Micro Hydropower prospective in Pakistan:
In Pakistan micro hydropower is used for power generation in some areas in which the most famous for such type of project is district Chitral. Due to AKRSP's initiative, Chitral has the most schemes and highest microhydel concentration. Only about 77% of all households in Chitral are electrified in which the major role were played by micro hydropower projects. The Sarhad Rural Support Programme (SRSP) has built seven micro hydels, the Chitral Area Development Programme (CADP) 37 installations. The Aga Khan Rural Support Programme (AKRSP) is with more than 150 installed micro hydro power plants by far the most important non-governmental player, bringing electricity to "50 percent of the population of Chitral." The fourth actor comprises the several NGOs that have installed a considerable number of community-managed micro hydels (Maier, 2007).
In the northern areas Pakistan the estimated potential for mini/micro hydropower schemes is said to be 300 MW. In which the capacity available for single plant is 100KW. At present out of the total potential only 10MW were utilized by micro hydropower projects. The total number of projects were 300 launched by full or partial support of the Aga Khan Rural Support Programme (AKRSP), Pakistan council for renewable energy and technology (PCRET), European Union (EU) and private developers (AEDB & GTZ, 2005).

1.2 Micro Hydropower Technology:

While there are various possibilities for the layout of a hydropower scheme, micro hydels in developing countries are most often designed as 'run-of-river' schemes. These projects have no storage reservoir. The water is either directly drawn from the stream or by using an intake structure and a small dam or weir, made of rocks to increase the water level. The water is then divided by the intake structure into the headrace or power canal. The headrace can be an open channel or a pipe. There upon the water enters the forebay, where sediments in the water settle before it enters the penstock. Most schemes generally have a spillway, to safely remove excess water. The penstock, most often steel-made, is a high pressure-pipe that supplies the water from the fore-bay tank to the turbine, placed inside the powerhouse. The spent water returns via a tailrace back to the river. Due to the non-existence of a reservoir, micro hydro technology "can be regarded as a technology with only minimal environmental impacts." Inside the powerhouse, water exits the penstock through a specially designed nozzle. By striking the turbine the energy from the falling water changes into rotational energy, which transferred by means of a belt, spins a generator that transforms the mechanical rotational energy into electrical energy (Maier, 2007).

1.3 MHP Project in study area:

The micro hydropower project was launched in 2007 on upper swat canal (USC) near kandow village, Lundkhwar. The MHP project is working under the recommendations of Sarhad hydel development organization (SHYDO), by the investment of Blue Star Energy Pvt. Ltd. Currently 1Mw is generating from hydel power but it has the capacity to generate up to 3MW electricity from the hydel power. It provides the electricity for both domestic and industrial purposes. A steel factory is also running nearby utilizing the power of MHP project, in which people belongs to local area got different jobs that includes technical, administrative, security staff and labors from local area. The micro hydropower project create a number of direct and indirect jobs as well as facilitate the existing businesses dependent on power sector. The layout of micro hydropower is run-off canal or Barrage-type.

2. MATERIALS AND METHODS

This section illustrates the research methodology that was used in conducting the study. This includes universe of the study, sample size, tools of data collection and analysis followed by research study.

2.1 Universe of the study

District Mardan constituted the universe of the study. The total area of the district is 1632 square kilometers. According to 1998 census, the population of district Mardan is 1.96 million. The urban proportion of the district is 20.2% of the total population whereas the rural proportion is 79.8%.

2.2 Sample and sample size

Three villages namely Kandow, Madad khan banda and Chiel in Lundkhwar were purposively selected as majority of the households got employment from the project belongs to these villages. The total population of the beneficiaries was 250 households from this project. A 30% of the population was taken as sample for the study. Table 3.1 shows total number of households and sampled households in the selected area.

2.3 Data collection and analysis

The interviewing schedule were used as data collecting tool for primary data regarding employment or jobs created by the MHP project. Data were collected randomly from the sampled households. After collection of data, data analysis were done with the help of supporting software SPSS.

To get the effect of the project on income and expenditure of the sampled households, paired t-test were used to test the hypothesis, H_1= *The MHP project effect the income and expenditure of the sampled households.* The formula is given below (Chaudhry and kammal 1996) .

$$t = \frac{\bar{d}}{Sd/\sqrt{n}}$$

Where as

$$\bar{d} = \frac{\sum di}{n}$$

$$Sd = \frac{\sum(di - \bar{d})^2}{n-1}$$

3. RESULTS AND DISCUSSION

Table 3.1 showing number of total and sampled households in each village. Table 3.2 Showing that roundabout (57%) of the households belong to the category having upto-8 members while (33%) belongs to 9-12 members per household. The above-12 category were only (9.3%). At village level the average household size in kandow were (8.1) similarly in Madad khan banda it were calculated as (8.2) while in Chiel the average household size were (7.6). The overall average (8.1) revealed that each household had family size upto-8 member. According to Population Census Organization (1999) the average household size in district mardan was 8.4 that are comparable to the current average of household size. The reason for which the family size goes higher is the preference for more males in the families for which a general

perception is that males can support the family more better in comparison to females as a result of struggle for more male labor force the families increase their family size.

Table 3.3 Showing that majority (96%) of the respondents were agreed that their family income has been improved. The households with improvement in family income had given the reason of employment of their unpaid family workers, involved in subsistence farming before the project in area. While only (4%) in the sampled population didn't experienced any improvement in their family income. Those having no improvement in their family income given the reason of high inflation in last years. Earlier Calderon (2005) found positive impact of micro hydropower projects on family income and rural livelihood of direct and indirect beneficiaries of micro hydels in Peru. Anup and Ian(2009) in Nepal, Kirubi (2009), and Rai (2000) in Kenya also found MHPs significant for improvement in family income.

It is evident from table 3.4 That (90.3%) of the respondents were given the same reason as the availability of off-farm employment opportunities due to the project in area. While (6.9%) were those whose income has been improved due to crop or live stock production or any kind of raw production from agriculture sector using high yielding varieties of sugar cane, wheat and maize. Which were the major cash crops in the area. The low percentage due to crop or live stock were because of the reason that majority of the respondents having agriculture occupation, were involved in below subsistence level (12.5 acres) farming and share cropping system. Those having own business, benefited from the project and having improvement in income were (2.8%) respectively. Calderon (2005), evaluating the impacts of MHPs on rural economy in Peru, also found MHPs helpful in improving family income by creating new job opportunities and improving local business like grocery shops, print shops, rooms for rent and small entrepreneurship, local cottage industry and small mechanical industry. Khennas and Barnett (2000) also found MHPs helpful in supporting small enterprises, local mechanical and cottage industry and creating jobs for the direct and indirect beneficiaries in Kenya, Nepal and Srilanka.

Table 3.5 indicates that about (47.48%) of change has been observed in the monthly income of sampled households. The percentage of change in monthly income of village Kandow is (48.68%) while in Chiel it is (46.55%) and (44.93%) increased was noticed in Madad khan banda. The higher change in per month income in kandow village were due to the agriculture occupation of the majority so the individuals working before project as unpaid family worker, were now found a paid off-farm employment due to the project in area and as a result their income were increased. To find the effect of the project on income of the sampled households t-test has been used to test the hypothesis of paired observation (income before and after the project). Taking $\alpha = .05$ the P-value is (.000) showing that $P<\alpha$ ($.000<.05$), so we reject our null hypothesis. As a result it is concluded that the mean incomes are not equal and the project effect the average income. Calderon (2005)in Peru also noticed a change of 40-50% in family income directly or indirectly dependent on micro hydropower project for income generation.

It is evident from table 3.6 that change in monthly income occurred in each category. About (40%) of change occurred in (2001-3000) category followed by (30.7%) change in (Above4000) category. While change in the (3001-4000) category were calculated as only (21.3%) as well as (4%) change were shown in both the category of (1001-2000) and (0-1000) respectively

Table 3.7 Shows the percent of change in monthly expenditure of sampled respondents. About (46.71%) of increase was observed in the expenditure of the sampled population. The range of change in expenditure was high (47.86%) in

Kandow followed by Chiel (45.48%) and Madad khan banda (44.85%). The more change in expenditure in kandow is due more increase in income in comparison to other two villages. t-test is used to test the hypothesis about two means with paired observations. As $P<\alpha$ (.000<.05) so we reject the null hypothesis and accept that project had effected the average expenditure.

Table 3.8 Shows improvements in the living condition of sampled population after the project. About (33%) has reported improvement in their house structure that includes construction of new portion or renewal of old sections in their houses. As the average household size in the sampled population were about (8.1) that indicates that more space has been needed in houses of sampled households. About (17%) had reported improvements in their household intake. The respondents with improvements in children education were (18%) that revealed that respondents had spent more on education of their children as compare to household intake (17%). About (10.7%) of the respondents reported improvement in health condition while (9.3%) of the respondents reported improvements in both and health conditions and children education. Similarly respondents with improvements in both household intake and health conditions were about (10%). Noor (2002) in Pakistan found positive impacts of MHPs on health, education and sanitation of the local communities in Chitral, Anup and Ian (2011) in Nepal also concluded the positive impacts of micro hydropower projects on improving the health and education and other infrastructure of the rural communities in countries

4. CONCLUSION AND RECOMMENDATIONS

About 47.48% increased was calculated in income and about 46.71% in expenditure of the sampled households due to the availability of jobs from the MHP project. Majority (33.3%) had spent extra money on improving their house structure (constructing new rooms, kitchen, washroom, toilets, replacing wooden gates with steel made gates), about (18%) spent on children education and (17.3%) improved their household intake. It shows that utilizing all the available efficiency of 300-MW in northern areas of Pakistan, for such type of micro hydropower projects can bring positive change in power generation sector as well as capable to solve unemployment problem in rural areas.

Proper geological survey must be carry at UC-level to find out the overall potential available for micro hydropower projects. Availability of stream-flow data of major and minor streams/canals in our villages and valleys can be helpful for all the interested groups whose like to invest in hydropower production through mini, micro or small micro hydropower projects. Financial institutions has to facilitate MHP-based projects by delivering small business loans on easy terms and conditions for local business groups, interested to invest in MHP projects including production of electricity as well as installment of small industrial units in local areas. It is necessary to build link roads to insure access to difficult sites for micro hydropower projects in rural and mountainous areas. Reduction in taxes or custom duty on all the imported machinery that is used in micro hydropower projects can facilitate MHP projects at community level.

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Table 3.1 Total household and sampled size in each village

Name of village	Total No. of Households	No. of Sample Households
Kandow	140	42
Madad khan banda	70	21
Chiel	40	12
All	250	75

Source: field survey 2012.

Table 3.2 Household Size of Sampled Households

Villages	Household size (No. of Persons)								
	Upto-8		9-12		Above12		Average	Total	
	No.	%	No.	%	No.	%	-	No.	%
Kandow	24	55.8	14	54.5	4	57.1	8.1	42	56
Madad Khan Banda	12	27.9	7	27.3	2	28.6	8.2	21	28
Chiel	7	16.3	4	18.2	1	14.3	7.6	12	16
Total	43(57.3)	100	25(33.3)	100	7(9.3)	100	8.1	75	100

Source: Field Survey 2012. Note: Figure in parentheses are percentages.

Table 3.3 Distribution of Respondents on The Basis of Improvements in Family Income

Villages	Improvement in family income				Total	
	Yes		No.			
	No	%	No	%	No	%
Kandow	39	54.2	3	100	42	56
Madad Khan Banda	21	29.2	-	-	21	28
Chiel	12	16	-	-	12	16
Total	72(96)	100	3(4)	100	75	100

Source: Field Survey 2012. Note: Figure in parentheses are percentages

Table 3.4 Reasons for Improvements in Family Income

Villages	Reasons for income improvements							
	Small Business		Job opportunity from MHP project		Crop/livestock production		Total	
	No.	%	No.	%	No.	%	No.	%
Kandow	2	100	34	52.3	3	60	39	54.2
Madad Khan Banda	-	-	21	32.3	-	-	21	29.2
Chiel	-	-	10	15.4	2	40	12	16.7
Total	2(2.8)	100	65(90.3)	100	5(6.9)	100	72	100

Source: Field Survey 2012. Note: Figure in parentheses are percentages.

Table 3.5 Percent of Change in Monthly Income

Villages	Respondents	Average income/month (Rs)		%age change	t values	
		Before project	After project		t value	P Value
Kandow	42	4542	8852	48.68%	12.889	.000
Madad Khan Banda	21	4423	8032	44.93%	13.405	.000
Chiel	12	4066	7608	46.55%	13.05	.000
Total	75	4433	8423	47.48%	19.093	.000

Source: Field Survey 2012.

Table 3.6 Change/Increase in Monthly Income

Villages	Range of change in monthly income (000)											
	0-1000		1001-2000		2001-3000		3001-4000		Above4000		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Kandow	3	100	1	33.3	12	40	10	62.5	16	69.6	42	56
Madad Khan Banda	-	-	2	66.7	10	33.3	4	25	5	21.7	21	28
Chiel	-	-	-	-	8	26.7	2	12.5	2	8.7	12	16
Total	3(4)	100	3(4)	100	30(40)	100	16(21.3)	100	23(30.7)	100	75	100

Source: Field Survey 2012. Note: Figure in parentheses are percentages.

Table 3.7 Percent of Change in Monthly Expenditure

Villages	Respondents	Average expenditure/month (Rs)		%age change	t values	
		Before project	After project		t-value	P-value
Kandow	42	4363	8369	47.86%	15.904	.000
Madad Khan Banda	21	4209	7633	44.85%	16.726	.000
Chiel	12	3925	7200	45.48%	9.894	.000
Total	75	4250	7976	46.71%	22.743	.000

Source: Field Survey 2012

Table 3.8 Improvements in Living Conditions of Sampled households

Villages	Improvements in living conditions													
	Improvement in household intake		Improvement in health conditions		Improvement in house structure		Improvement in children education		Improvement in HH-intake and health conditions		Improvement in health conditions and children education		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Kandow	7	53.8	4	50	13	52	9	64.3	5	62.5	4	57.1	42	56
Madad khan banda	5	38.5	3	37.5	7	28	4	28.6	-	-	2	28.6	21	28
Chiel	1	7.7	1	12.5	5	20	1	7.1	3	37.5	1	14.3	12	16
Total	13(17.3)	100	8(10.7)	100	25(33.3)	100	14(18.7)	100	8(10.7)	100	7(9.3)	100	75	100

Source: Field Survey 2012. Note: Figure in parentheses are percentages.