EVALUATING THE IMPACT OF ALTERNATIVE FUEL TECHNOLOGY ON FOREST RESOURCE CONSERVATION: A CASE STUDY OF GALIAT REGION, KHYBER PAKHTUNKHWA

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Abstract

Forest depletion is one of the serious environmental concerns in Pakistan. The already meager forest resource is under severe anthropogenic pressure and is vanishing rapidly. Lack of alternative to fuel wood is one of the major underlying causes of the forest depletion. Many efforts have been made to reduce the pressure on natural forests by introducing new technologies such as Solar Water Heaters. Solar Water Heaters have been introduced in Galiat valley to reduce pressure on natural forest resource for fuel wood. This study was designed to evaluate the impacts of this alternative fuel technology on forest resource conservation and find out its social and economic impacts on the rural dwellers. The results of the study are encouraging as the technology adoption has significantly reduced the fuelwood consumption and hence pressure on the forests. Similarly, the technology has contributed significantly in improving the socio-economic condition of the households using this technology.

Key Words: Solar Water Heaters, Forest Conservations, Social and economic impacts, Fuel Wood

Introduction

In Pakistan, the forest resource is limited with about 4.51 million ha area under forest cover which corresponds to 5.1% of total area of the country (Bukhari *et al*., 2012). According to Suleri (2002), the studies based on remote sensing confirm that the forest cover in Khyber Pakhtunkhwa will completely disappear in the next 30 years if the present rate of deforestation continues. The depletion of forest resource is one of the major environmental issues for the country. According to an estimate 39 thousand hectare of forests are vanishing annually. The report of FAO (2005) elucidates that the deforestation rate in Pakistan was 1.5% per annum between 1990 and 2000. Pakistan use electric facility (41.7%) and natural gas (1.4%) which is quite less than its use in urban communities. While use of fuel wood (32.1%), LPG (3.9%), kerosene oil (4.2%), dunk cake (5.5%), agriculture residue (7.1%), candles (2.3%) in rural areas is more than its use in urban communities. Poverty is widespread as in Khyber Pakhtunkhwa, 41% population is earning less than USD 1 per day and living below the poverty line. (Multi Indicator Cluster Survey of NWFP- 2001).

In order to reduce pressure on natural forests, several programmes have

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been initiated by various agencies in forested areas of Pakistan. One of such programmes is the Building and Construction Improvement Program (BACIP) which addresses rural household energy, indoor pollution, and associated health related issues through Energy Efficient and Household Improvement (EE&HI) products and technologies (stoves, water warming facility, insulation etc). The program was operational in the Northern Areas of Pakistan.

The programme has been very promising in terms of reducing pressure on forests. The project interventions resulted in 50% savings in fuel wood consumption for heating/cooking (equivalent to US$ 35-45/yr); 25% reduction in health bills; 50% reduction in house repair costs; 50% reduction in smoke related diseases. (Shah, 2007). Tucker (1999) reported that due to use of solar cookers fuel wood use was reduced by 36% corresponding to 246 million metric tons of wood (approximately) each year.

Based on the success of BACIP, World Wide Fund for Nature-Pakistan and World Vision-International, Pakistan replicated the solar water heaters in the selected villages of Galiat in the year 2010-11 to promote the alternative fuel technologies with the aim to reduce pressure on the natural forest resource. This study was conducted to assess the efficiency of Solar Water Heaters in reducing fuel wood consumption and to determine the social, environmental and economic benefits of the technology adopted in the target area.

Material and Methods

The Study Area

The study area lies between 33°-56' and 34°-21',72°-55' and 73°-29' in Abbottabad district of Hazara Division of Khyber Pakhtunkhwa. The eastern limits of the tract are bounded by Jhelum River; the southern by Satura range of Haripur forest division, the western by Haripur Tehsil boundary and northern limits by Mansehra District. The ethnic groups residing in and around forests are Karalls and Abbasies. They speak a common language known as Hindko. Other groups like Syeds, Mughals, Awans, and Rajputs are present. The two major forest types are Reserved Forest and Guzara Forests. The major forest type occupied by reserved forests consists of the Himalayan temperate forests extending from the elevation zone of 8000ft altitude. The Guzara forests can be classified in to the following types: Sub-tropical Chir pine forests; Low level blue pine forests; and Western Mixed Coniferous Forests.

Methodology

The population of the study comprised all the rural households of the target villages of Galliyat where the alternative fuel technologies (Solar Heaters) have been installed by WWF/World Vision. The total number of these villages where solar water Heaters were installed was 10 (90 households) These villages included Samundar

Katha, Nagri Bala, Kala Ban, Sukka Kass, Bandi Mera, Mera Kalan, Mera Khurd, Barian, Sangi Mera and Pangoora. All the 90 households' heads were interviewed during field survey using a structured questionnaire.

Besides field survey, formal and informal meetings with representatives of the two organizations i.e. WWF and WVI were held to know their views and analysis about the nature, purpose, location, cost and beneficiaries of the technology and its adoption in the area. They also provided relevant data about the distribution and installation of Solar Heaters.

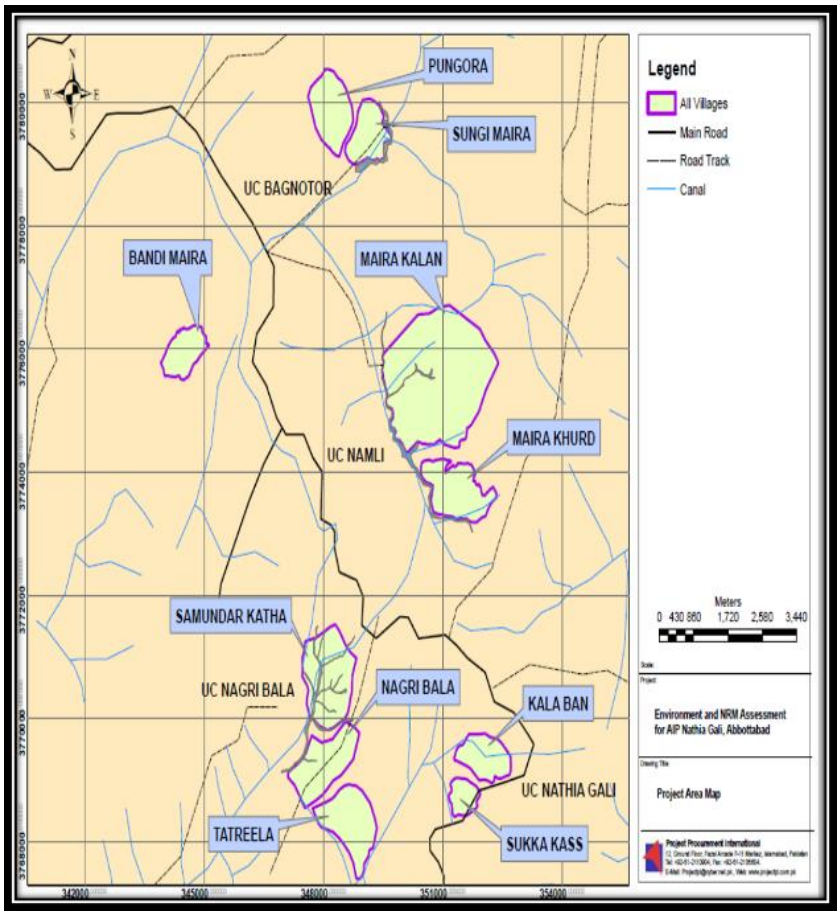

Fig. 1. Map of the study area

Source: Environment and Natural Resource Management Assessment Report for Area Integrated Programme in Nathiagali, Abbottabad, 2010.

A structured questionnaire was used to gather data from the respondents. It was prepared in English but presented in Hindko language (local language) to collect the relevant information. Prior to data collection, the interview schedule was pre-

tested on 10 respondents and necessary amendments were made accordingly. The data was tabulated using descriptive statistics. The data was analysed statistically by using Statistix 8.1 software. Means were compared using t-test at p=0.05 significance level.

Results and Discussion

Impact on Forest Resource Conservation

The average household fuel wood consumption in summer before the technology was 13.089±3.50 Kg per day while after the technology it was 7.08±1.90 Kg per day. It means that 5.77±3.19 Kg of wood was saved per day per household with the installation of Solar Water Heaters (SWHs). Total saving of fuel wood of 90 houses is 540 Kg per day in summer. Due to adoption of SWHs, *c.*46% reduction in fuel wood consumption was observed in summer. The fuelwood consumption in summer was significantly higher before the adoption of technology (t =12.04, one-tailed, P<0.05).

The average household fuel wood consumption in winter was estimated as 16.4±2.97Kg per day before the technology while after the technology fuel wood consumption was 7.82±2.09 Kg per day per household. Thus, there was a saving of 8.68±2.26 Kg per day per household in winter. The total saving of 90 houses is 808 Kg per day. In winter, fuelwood consumption was reduced by *c.*52% due to adoption of SWHs. The fuelwood consumption in winter was significantly higher before the adoption of technology (t =24.59, one-tailed, P<0.05) as reflected in Table 1.

Table 1. Fuelwood Consumption: Pre and Post comparison

Season	Average amount of fuel wood before the technology (kg/day/household)	Average amount of fuel wood used before the technology (kg/day/household)	Net Saving (kg)	t-value	P
Summer	13.089±3.50	7.08±1.90	5.77±3.19	12.04	<0.05
Winter	16.4±2.97	7.82±2.09	8.68±2.26	24.59	<0.05

People living in the Galliyat region preferred using Pine trees, mainly Kail (*Pinus Wallichiana*) and Oak (*Quercus sp*.) to meet their fuel wood demand. About 66.4% Kail and 33.6% Oak were used by the people as fuel wood. Total 388Kg Kail and 181Kg Oak was saved in summer and 536Kg and 271Kg of Kail and Oak saved in winter respectively after the installation of SWH.

In summer, volume of 651 cft/day of Kail and 259 cft/day of Quercus was the net saving using SWHs technology. Whereas in winter, 975 cft/day of Kail and 387 cft/day was the net saving using SWHs. Assuming 20'' dia for both Kail and Quercus to be the reasonable one for conversion, the number of Kail and Quercus trees saved in summer are 8 and 4 per day respectively. Whereas in winter, the number of

Kail and Quercus trees saved in summer were 12 and 6 per day respectively (Table 2).

Table 2. Number of Trees saved/conserved after the adoption of solar water Heaters

Species	Net Saving (Cft/day)		No of Trees Saved/day)	
	Summer	Winter	Summer	Winter
Kail	651	975	8	12
Quercus	259	387	4	6
Total	910	1362	12	18

These findings are in consonance with Abbaspour and Ghazi (2012) who concluded that the promotion of the adoption of renewable energies in deprived and remote areas can be considered as an important step towards reduction of threats to the loss of biodiversity through community mobilization. The results are also in conformity with Tucker (1999) reported that due to use of solar cookers, fuel wood use was reduced by 36% corresponding to 246 million metric tons of wood (approximately) each year. Milton (2006) reported that since many rural households rely on fuel wood to meet their water heating needs, an immediate benefit is that pressure on local fuel wood sources could decrease, supporting efforts to combat deforestation and desertification.

Social Impacts

One of the significant social impacts of SWH was the time saving for women as a result of adoption of this technology. Table 3 shows that majority of the respondents (27%) were of view that more than 4 hours of time was saved as a result of SWHs adoption. About 25% reported that 3-4 hours was the net time saving due to SWH. The mean time saving as result of SWH was 2-3 hours. These results are in consonance with Wlokas (2011) who concluded that the solar heaters have saved the time of women involved in the collection of fuelwood.

Table 3. Time saving after the adoption of Solar Water Heater

Time Saving (Hours)	Frequency	Percentage
<1 Hour	10	11
1-2 Hours	14	15
2-3 Hours	20	22
3-4 Hours	22	25
>4 Hours	24	27
Total	90	100

Economic Benefits

Data analysis exposed that 358kg and 181 kg of Pine and Broad leaved species per day were consumed in summer while 536kg and 271kg of Kail and Oak were consumed in winter respectively. Net saving in summer of both species was valued at PKR. 1790 and PKR. 1086 per day respectively while net saving in winter of both species was PKR.2680 and PKR.1626 per day respectively.

Table 4 reveals that SWH have also resulted in the reduction of electricity bills. Before the installation of SWH, the average bill of electricity was PKR.905 whereas after the installation it was PKR.545 per household. The net saving in the electricity bills due to SWH accounts for PKR. 60 per household. Furthermore, the paired t-test value infers that the electricity bills have been significantly reduced after the adoption of solar water heaters (t-value=25.5, P=<0.05, one tailed)

Table 4. Electricity Bills: Comparison Before and After Adoption of Technology

Electricity bills before the technology (Rs/household)	Electricity bills after the technology (Rs/household)	Net Saving (Rs/household)	t-value	P
905	545	60	25.50	<0.05

The findings of the study conform Shah (2007) who concluded that the results of Energy Efficient and Household Improvement (EE&HI) products and technologies (stoves, water warming facility, insulation etc) introduced by Agha Khan Programme in Northern Areas Pakistan included 50% savings in fuel wood for heating/cooking (US$ 35-45/yr.); 25% reduction in health bills; 50% reduction in house repair costs; 50% reduction in smoke related diseases; and reduction in drudgery chores of women and children and saved time.

Conclusion

The results of the study are encouraging as the solar water heaters as an alternative to wood have been successful in terms of having positive impacts on forest resource conservation and also had good social and economic impacts. The technology has significantly reduced the fuelwood consumption and hence can be considered as an option for fuelwood replacement in hilly areas. Similarly, time of women involved in fetching fuelwood from forests has been reduced to greater extent and this time can be used for other productive activities. Fuelwood cost and electricity bills have also been significantly reduced after the introduction of solar water heaters.

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